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## THE THEORY OF CHEMICAL ACTION IN ELECTRICAL DISCHARGE<sup>1</sup>

THAT slow chemical action accompanies various types of electrical discharge in many gases has been long known. Berthelot<sup>2</sup> summarized and reviewed the earlier as well as his own work, in which the arc, spark or silent discharges were applied to a large number of gases or gaseous mixtures. At that time little or no attempt was made to find a general mechanism or theory. This is not surprising if we remember that almost nothing of our present ideas of discharge in gases was then known. While some of the early results have not been confirmed by later work, most of them have been, and many of the unusual products have also been found in other ways, for example, under *alpha* radiation, proving that the early work of Berthelot, Thenard, Brodie and their contemporaries offers many valuable leads and forms a basis for further progress.

Naturally the first attempts to find a theory for the electrochemical effects in gases were directed toward a correlation between the current flowing and the amount of action produced according to Faraday's law. The disagreement found in the exhaustive researches of Warburg and of others, while unexpected, was so unmistakable that these efforts had to be abandoned.

The theories advanced since then attribute the effects to one of the following agencies: (1) Photochemical; (2) Static ions; (3) Critical activation by kinetic ions. Upon failing to find a relation between current and chemical effect, Warburg quite early adopted the idea that ozone formation, for example, might be due to the ultra-violet light accompanying the discharge. In his review<sup>3</sup> of the subject in 1925 he still adhered to this hypothesis.

The equality of ozonization and ionization of oxygen by means of Tesla discharge convinced Krüger in 1912 of a static-ion theory of ozone formation. Simultaneously a study of ozonization under  $\alpha$  radiation led me to the same conclusion, and to a generalization of this theory (as also Krüger) to explain all

<sup>1</sup> The presidential address, presented at the fifty-third general meeting of the American Electrochemical Society at Bridgeport, Conn., April 26, 1928. Colin G. Fink in the chair.

<sup>2</sup> M. Berthelot, "Essai de Mécanique Chimique," Vol. II, Chap. 11 (Dunod, Paris, 1879).

<sup>3</sup> Zeit. f. techn. Physik., 1925, p. 625.

cases of excess of chemical action over current prediction in gaseous discharge, which excess Warburg had shown might readily reach 1,000 fold.

The central hypothesis of the static-ion theory is that the chemical action is the direct result of recombination of positive and negative ions in the bosom of the gas, which never reach the electrodes and hence can have no relation to the current. In fact this represents in some respects a complete antithesis to the conditions of electrolytic reaction. In electrolysis it is the ions which conduct that react chemically, while in gaseous discharge it is the ions that recombine without conducting that react chemically; possibly the ions which conduct also react chemically at the electrodes, but their proportion is a negligibly small part of the total ionization under usual conditions of chemical action in gaseous discharge. In other words, an intensity of ionization that corresponds to measurable chemical action on a basis of equivalence is far outside the range in which saturation current can be produced or even approached. Any attempt to attain saturation by applying more voltage simply produces more ionization by electronic collision, and defeats its purpose by a yet wider margin.

Not only is it impossible to measure the total ionization accompanying electrical discharge through gases, but the theory of the discharge is so imperfectly understood that we are not able to calculate any comparison of the chemical yield with ionization in gaseous discharge.

The question must arise then: Is it important to establish this yield factor? The answer must be affirmative from several standpoints. The information gained about the chemical yield per ion in other types of ionization, especially by *alpha* radiation, has indicated that it is a fundamental constant for a given reaction. We also have much evidence, which is rapidly being strengthened, that the nature of the reaction and of the products is the same for different types of ionizing agencies. This is just what we should expect if the reactions are due to ionization, that the means of producing the ions ought to make no difference, or at least only secondary differences in the character of the reaction.

If this principle can be thoroughly established, then we can reverse the process and use a reaction of known chemical yield per ion to determine the ionization in electrical discharge. This suggestion applies equally well to the high-speed electrons from a Coolidge tube, or to any other ionizing agencies that produce chemical effects, excepting, of course, those types such as arc or spark discharge when temperature effects intervene. If the chemical yield per ion-pair remains constant for a given reaction, whether this ionizing agent be  $\alpha$  rays,  $\beta$  rays, X-rays or heavy

recoil atoms, there is no reason to foresee that it will not also be true in ionization by electronic discharge.

It has been quite certain for some time that chemical action produced by  $\alpha$  rays is not only proportional to, but strictly equivalent to, the ionization. This equivalent is not equal to the Faraday equivalent, but greater within restricted limits. Since for nearly all  $\alpha$  ray reactions the value of  $M/N^*$  exceeds unity, usually having values between 2 and 20, we must assume some kind of multiplying process which acts either collectively or successively. The former seems more likely as a working hypothesis, so that we may assume ion clusters, for the existence of which there is also some physical evidence.

Unfortunately, the positive ray method, which gives us the most definite information about gas ions, is not applicable to the study of ion clusters, because it can be operated only at very low pressures, where the collisions necessary for clustering can not occur, and where the clusters if once formed would probably dissociate. Another general method, that of studying ions by means of their velocity of migration in a field, has not proved satisfactory in obtaining the mass of ions. Therefore the chemical method once firmly established may prove to be the best method of studying clustering.

The clustering hypothesis of mechanism of chemical action produced by gas ions may be briefly stated as follows: When a gas molecule is ionized by having one of its electrons removed, a minimum amount of work is required, which regarded thermally is very large, 10 to 20 electron-volts (or 230,000 to 460,000 calories per mole.) for different gases. This leaves a positive ion possessing a large amount of latent energy, and which owing to its charge will exert an induced attraction on neutral molecules that approach or collide with it, thus forming an ion cluster while still retaining its positive charge.

We do not know precisely the size of these clusters nor the efficiency of collision in clustering, but the chemical  $M/N$  ratios give a minimum—probably a critical—value for the portion which we may call the *chemical cluster*; while the physical cluster may be larger, and possibly is in dynamic (not kinetic) equilibrium with the colliding neutral molecules and is hence variable rather than critical in size. When the free electron or, in case a gas with electron affinity is present, the negative ion or cluster again unites with the positive cluster, the high energy of ionization is set free, and the cluster either dissociates to the original components (the energy being kinetically degraded to heat) or it may dissociate partly or wholly into the

\*  $M/N$  is the chemical yield per ion-pair,  $M$  being the number of molecules reacting for  $N$  ion-pairs produced.



elements or into new products of higher heat content, or may be largely stabilized to a product of high molecular weight. The heat of ion-recombination is either radiated<sup>5</sup> away or carried off by some of the molecules from the cluster.

The following empirical rules have been found for the size of that part of the cluster which reacts chemically, that is, for the  $M/N$  ratio. (1) In gaseous systems of one component with no affinity for free electrons,  $M/N=2$  (approximately), which means first a positive cluster of about two molecules, which reacts chemically upon being restored to electrical neutrality by the free electron. (2) In gaseous systems of two components one of which is oxygen and the other an oxidizable substance,  $M/N=2 \times$  (simplest stoichiometric reaction formula), one cluster belonging to the positive ion and the other to the negative (oxygen) ion. (3) In unsaturated compounds  $M/N$  is usually greater, lying in the region 5 to 20 molecules per ion-pair, the direct products being liquid or solid, confirming a high degree of clustering.

Recent work<sup>6</sup> on the effect of different kinds of electrical discharge, on ethane and on propane gases, has shown that the products both gaseous and liquid are quite similar to those obtained from the same gases by  $\alpha$  radiation. Lower hydrocarbons are condensed to higher ones by the elimination of hydrogen or methane, with the formation of some liquid hydrocarbons. In the action on ethane in a Siemens tube, the ratio of methane to hydrogen liberated was quite close to that found for the condensation of ethane, propane, or butane under  $\alpha$  radiation.

This makes it evident that the reaction has the same character and general mechanism in both cases, and if due to ionization, as is very probable for the  $\alpha$  ray cases, then ionization must also be the primary step in chemical action under electrical discharge. Further we may predict that the character of the reaction should be more or less independent of the type of discharge, which we have found to be the case. Some secondary differences are found. For example, the more disruptive the type of discharge the more tendency there is for liberation of free carbon, and for the formation of insoluble solid hydrocarbons.

All of the predictions made from the  $\alpha$  ray results, however, have been so thoroughly supported by the subsequent experiments in electrical discharge, that it seems safe to assume the same general kind of mechanism in both cases.

The acceptance of the static-ion mechanism of reaction in discharge has, however, not been general,

<sup>5</sup> F. L. Mohler, *Phys. Rev.*, 31, 187 (1928).

<sup>6</sup> Lind and Glockler, *Trans. Am. Electrochem. Soc.*, 52, 37 (1927).

perhaps mainly due to the lack of a knowledge of the ionization in order to evaluate the equivalence ( $M/N$  ratio). The conditions in electrical discharge are much more complicated than in ionization by radon, and suffer from the great disadvantage that the generation of ions is dependent on the field, and at any pressure above a few millimeters varies with it in a very complicated way.

Even in the  $\alpha$  ray work some authorities have felt that it ought to be possible to demonstrate directly the chemical effect of ionization by diminishing or increasing in some independent way the number of ions, and correspondingly the number of molecules made to react. This is however quite impossible, because we have no means of adding more ions, from an independent quantitative source, to the intense ionization already necessary to produce a measurable rate of chemical action. Nor is it possible, as we have seen, to withdraw any considerable fraction of the ions, since such high fields must be applied that a larger but unknown quantity of new ions is at once produced.

The recent success of applying the quantum theory in various directions, especially to photochemistry, has frequently led to the belief that although the reactions under discussion are accompanied by and are proportional to ionization, they must, however, be directly caused by *excited* rather than by ionized molecules. It is sometimes lost sight of that ionization itself represents a wholly quantized as well as a highly energized state, and that there is every theoretical reason to believe that ions are equally if not more reactive chemically than excited molecules, because on account of the high electrical field of ions they exert a larger sphere of influence. We have then just as good reason to expect that the quantum law should apply to ionic-chemical as to photochemical reactions and, as a matter of fact, we have been successful in demonstrating its application in many cases, and without the prevalence of the marked exceptions which characterize the experimental tests of the Einstein Law.

The principle of a third theory, recently proposed from Prof. Donnan's laboratory by Elliott, Joshi and Lunt,<sup>7</sup> might be identified with excitation, though apparently it originated from analogy with a yet less energetic type of activation. They postulate that the concept of "critical activation" may be applied to chemical action in electrical discharge. They assume, as in the collision theory of chemical activation, that the reaction rate is a function of the kinetic energy of the constituent particles, and that it is im-

<sup>7</sup> G. A. Elliott, S. S. Joshi, and R. W. Lunt, *Trans. Faraday Soc.*, 23, 57-60 (1927).

material whether the kinetic energy be of thermal or of electrical origin. According to this idea the activating energy might be the sum of kinetic energies of thermal and electrical origin. It would therefore be interesting to see whether reaction in electrical discharge has a positive temperature coefficient, as would be predicted by the theory. Many of the reactions under  $\alpha$  radiation do not have, thus supporting a static rather than a kinetic-ion theory.

Based on the hypothesis of the kinetic action of ions, Elliott, Joshi and Lunt developed an equation which it seems would apply equally well for activation by either ions, excited molecules or kinetically activated molecules. Two kinds of experimentation might give a decision in the case of electrical discharge: evaluation of the proportionality factor, as in the determination of  $M/N$  or  $M/h\nu$  values, or else by increasing the speed of homogeneous electrons until reaction begins. The difficulty of the former has been discussed. Work of the latter kind<sup>8</sup> on the reduction of CuO by  $H_2$  gave no indication of reaction until the excitation potential of  $H_2$  (11.4 volts) was reached, while Storch and Olson<sup>9</sup> and Andersen<sup>10</sup> found no synthesis of ammonia in low voltage arc until the ionization potential of nitrogen (17 volts) was reached.<sup>11</sup> Neither of these results supports the view that electrons produce chemical activation at low speed corresponding to critical activation potential—about 2 volts or 45,000 cal.

Hutchinson and Hinshelwood<sup>11</sup> have also recently investigated in a different way the possibility of a parallelism between electrical and thermal reaction mechanisms. They determine the relative decomposition of  $N_2O$  and  $NH_3$  gases in two similar discharge tubes, connected either in series or in parallel. Their results were hardly those to be expected from kinetic activation nor from thermodynamics, but appear to be capable through the following analysis of affording strong support of the ion-cluster hypothesis. They find under parallel conditions that about 4.8 to 7.6 times as many molecules of  $N_2O$  are decomposed as of  $NH_3$ . The electrode material made little difference, and the rates were first order with respect to pressure, both of which indicate reaction in the gas phase.

While we have rather meager information about the relative chances for different molecules to be ionized in a stream of electrons under potential fall

much greater than the ionization potential, it seems probable that the relative ionization of two gases might be about the same as for ionization by  $\alpha$  particles. Therefore we may expect at the same pressure in equal electron streams (approximately the same current) that  $N_2O$  would be ionized  $1.53/0.81 = 1.9$  times more than  $NH_3$ .

Furthermore, if the ions produced are of the same character as those from  $\alpha$  particles, we may assume that the chemical yield per ion pair will be equal for each reaction to the ion yield in  $\alpha$  radiation, which from Wourtsel's<sup>12</sup> results at  $18^\circ$  is 0.8 for  $NH_3$  and 1.74 for  $N_2O$  or a ratio  $1.74/0.8 = 2.2$ . Both of these factors operate in the same direction, to make the decomposition of  $N_2O$   $1.9 \times 2.2 = 4.2$  times that of  $NH_3$ , which approximates the factor found experimentally by Hutchinson and Hinshelwood.

It should be emphasized that the relative ionization of two gases is not directly related to their ionization potentials, but is as shown by Glasson, proportional to  $Z^{2/3}$  ( $Z$  = atomic number), or to the cross-sectional density of orbital electrons in the molecules through which a stream of  $\alpha$  particles (presumably also a stream of electrons) is passing. For example, the ionization potential of  $NH_3$  is 11.1 volts, while that of  $N_2O$  (hitherto not determined) should according to Eve's rule be about the same as that of  $CO_2$ , or about 14 volts, which in itself would give no grounds to expect that  $N_2O$  would be more readily decomposed than  $NH_3$ . Nor could we expect that  $N_2O$  on account of a higher ionization potential would be less frequently ionized than  $NH_3$ , because the electrons in Hutchinson and Hinshelwood's experiments are produced by an induction coil, and hence move under voltages far above the ionization potentials.

Claims that reaction in electrical discharge may be attributed to excitation rather than ionization have also been made. On a reexamination of the yield of  $O_3$  per ion-pair, Krüger and Utesch<sup>13</sup> estimate from new experiments a yield of 30 to 40  $O_3$  molecules per ion-pair which they attribute to excitation. Owing, however, to later confirmation<sup>14</sup> of the ion yield in ozone formation under  $\alpha$  radiation as  $M_{O_3}/N = 1$  to 2 and to the uncertainty of the measurement or calculation of ionization in electrical discharge, we are not prepared to accept the high yield as definite.

<sup>12</sup> E. Wourtsel, *Jour. de Phys. Rad.*, 11, 341, 345 (1919).

<sup>13</sup> F. Krüger and O. Utesch, *Ann. d. Physik.* (4), 78, 113-56 (1925).

<sup>14</sup> J. D'Olieslager, *Acad. Roy. Belg.*, 1925, 711; Mund and D'Olieslager, *ibid.*, 1926, 309; *Bull. Soc. Chim. Belg.*, 36, 399 (1927); Lind and Bardwell, "Chemical Effect of Alpha Particles," 2d Ed., p. 92. Chem. Catalog Co., N. Y., 1928.

<sup>8</sup> Geo. Glockler, W. P. Baxter, and R. H. Dalton, *J. Am. Chem. Soc.*, 49, 58 (1927).

<sup>9</sup> H. H. Storch and A. R. Olson, *J. Am. Chem. Soc.*, 45, 1605 (1923).

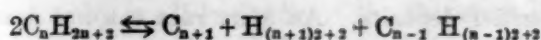
<sup>10</sup> E. B. Andersen, *Z. Phys.*, 10, 54 (1922).

<sup>11</sup> W. K. Hutchinson and C. N. Hinshelwood, *Proc. Roy. Soc.*, 117A, 131-6 (1927).



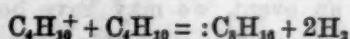
Finally, I should like to discuss briefly the mechanism of condensing lighter to heavier (condensed or polymerized) molecules either thermally, catalytically, photochemically or electrically. It appears that all of these methods have something in common, though the mechanisms that have been proposed may be differentiated into two quite distinct classes. (1) Primary reaction consisting of clustering followed by splitting (when it takes place) or (2) Primary reaction consisting in first splitting followed by a reassembling of the elements or radicals.

Of these two processes the former has appeared more plausible in conceiving mechanisms for the ionic reactions, and it has recently been suggested<sup>15</sup> that it may also be plausible in some photochemical processes. The hydrocarbon gases, for example, which were formerly thought to be quite difficult to change one into another, have only recently been shown to have great facility, for such changes. H. A. Wilson<sup>16</sup> has proposed, and thermodynamically supported, thermal equilibria of the type

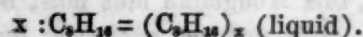


according to which, ascension in the hydrocarbon scale can be accomplished only by production of an equal number of molecules of lower molecular weight.

It is possible that this type of condensation may occur also in electrical discharge, but apparently more pronounced types predominate, which consist in doubling or multiplying through the elimination of one product of very low molecular weight ( $H_2$  or  $CH_4$ ) which evidently allows the other product to be correspondingly higher. To illustrate: thermally, according to Wilson,  $2C_4H_{10} \rightleftharpoons C_3H_8 + C_5H_{12}$ ; while ionically, according to Lind and Bardwell,<sup>17</sup>  $C_4H_{10}^+ + C_4H_{10} = C_8H_{18} + H_2$  or also



and



Evidently the ionic processes arrive more directly at the product of higher molecular weight, but with a much higher energy expense.

A mechanism by which building up of large molecules is effected by clustering, followed by partial splitting, seems more plausible than to assume that the splitting occurs first and building up subsequently. This may apply to some photochemical as well as to ionic syntheses.

<sup>15</sup> Lind, *J. Phys. Chem.*, 32, 575 (1928).

<sup>16</sup> H. A. Wilson, *Proc. Roy. Soc.*, 116A, 501-15 (1927).

<sup>17</sup> *J. Am. Chem. Soc.*, 48, 2346 (1926).

Referring to the statement of Elliott, Joshi and Lunt (*loc. cit.*) that, "Despite the numerous investigations that have been made on chemical changes produced by an electric discharge through a gas, no satisfactory general hypothesis has yet been suggested to describe the mechanisms of such changes," I should say that the fault lies rather with the inadequacy of the theory of electrical discharge in gases than with the hypothesis of the nature of the chemical changes produced. As long as we can neither measure nor calculate the ionization, any theory based on ionization must lack quantitative support and depend on indirect evidence, although it may later prove to be a correct theory. Proof that the velocity of reaction (K) is related to the pressure (p) at constant current by a linear relation of p to  $\log K/p$  would be equally true for the static-ion theory, since p must have a double function in determining the energy received from the electron stream (by any mode whatsoever—ionization, excitation or critical activation) and again in determining collisions between energized and ordinary molecules in the completion of the chemical reaction.

To review the two theories more generally, it would appear that if enough energy has already been expended to produce ions, a very large amount of latent energy is possessed by the ions, so that they need no additional kinetic energy to make them reactive toward other molecules. The only way to disprove this by energy considerations would seem to be by showing that a larger amount of action is accomplished than can be accounted for on the cluster theory. This involves evaluation of the proportionality factor which for electrical discharge has not yet been done and, as we have seen, can not be accomplished until the ionization can be determined. But if we may reason by analogy from the  $\alpha$  ray results, static ions without any kinetic energy (resulting from a field) are quite sufficient, and the yields found do not exceed the possibilities of clustering. That the  $\alpha$  ray results for the hydrocarbon gases may be applied by analogy to the chemical action of *electrical discharge* in the same gases has already been discussed.

Continuation of the work reported at the last meeting of the Society has yielded further confirmation of the ion cluster theory. By controlling the conditions of condensation<sup>18</sup> the average molecular weight of the liquid product from ethane has been lowered from 467 to 120.

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<sup>18</sup> Lind and Glockler, *J. Am. Chem. Soc.*, 50, June (1928).

## THE PLATEAU HABITAT OF THE PRO-DAWN MAN

Grounds for the pro-Dawn Man theory<sup>1</sup> are directly derived in part from existing embryological, anatomical and zoological evidence, in part from certain principles of animal descent or phylogeny which were entirely unknown in the period when Charles Darwin published his classic work, "The Descent of Man" (1871), and the shortly succeeding period when Huxley wrote his famous essay, "Man's Place in Nature." Although following Lamarek, who early in the nineteenth century sketched the apes as human ancestors, Charles Darwin required great courage to draw in 1871 the following picture of our ancestors:

The early progenitors of man must have been once covered with hair, both sexes having beards; their ears were probably pointed, and capable of movement; and their bodies were provided with a tail, having the proper muscles. Their limbs and bodies were also acted on by many muscles which now only occasionally reappear, but are normally present in the *Quadrumana*. At this or some earlier period, the great artery and nerve of the humerus ran through a supra-condyloid foramen. The intestines gave forth a much larger diverticulum or caecum than that now existing. The foot was then prehensile, judging from the condition of the great toe in the foetus; and *our progenitors, no doubt, were arboreal in their habits, and frequented some warm, forest-clad land.*

I take the liberty of italicizing the two most salient lines in this oft-quoted passage because they give the key to the thought of Darwin and of subsequent advocates of the ape-man theory down to the present time. Over against such a habitat which has framed the structure of all anthropoid apes may be placed the conclusion theoretically reached by the brilliant geologist, Joseph Barrell, in 1917, and independently reached by myself by direct observation during my journey of 1923 into the heart of the desert of Gobi. To my knowledge Barrell was the first to formulate what may be called a semi-arid plateau theory of the origin of man, as recently quoted by Charles Berkey in "Geology of Mongolia":<sup>2</sup>

... Among the many suggestive thoughts offered by Joseph Barrell (1917) as guiding hypotheses for our

<sup>1</sup> Before the American Philosophical Society, April 20, 1928, the author renewed his attack upon the ape-man theory of human ancestry which he began at the bicentenary meeting of the society in April, 1927.

<sup>2</sup> Charles P. Berkey, Frederick K. Morris: "Geology of Mongolia. Natural History of Central Asia," Vol. 11. Published by the American Museum of Natural History, New York, 1927.

explorations in central Asia, his idea about primitive man is especially ingenious. Man's strong padded foot, his relatively long leg and his erect posture, are all distinct departures from an adaptation to life in the trees, and tend, instead, to fit him for running and for tramping long distances; in short, for life on open plains where trees grow in patches along the stream courses, rather than for life in a dense forest. Granting that the more distant ancestors of men lived in trees and in jungles, it seems probable that they would have remained arboreal in an environment of jungle and forest. But in a region where forests were thinning, where open, treeless plains were beginning to appear, and where the climate was changing toward cooler and more arid conditions, it seems probable that arboreal types must adapt themselves to the plains, or become extinct.

I am not conscious of having seen or heard of Barrell's generalization prior to my own discovery of the same principle, which I enunciated before a gathering of geologists and natural philosophers in Peking:<sup>3</sup>

Mongolia was probably not a densely forested country—this is indicated by the animal remains found there in the earlier deposits. An alert race can not develop in a forest—a forested country can never be a center of radiation for man. Nor can the higher type of man develop in a lowland river-bottom country with plentiful food and luxuriant vegetation. It is upon the plateaus and relatively level uplands that life is most exacting and response to stimulus most beneficial. Mongolia always has been an upland country, through the Age of Mammals and before. It was probably a region forested only in part, mainly open, with exhilarating climate and with conditions sufficiently difficult to require healthy exertion in obtaining food supply. . . .

In the uplands of Mongolia conditions of life were apparently ideal for the development of early man, and since all the evidence points to Asia as the place of origin of man, and to Mongolia and Tibet, the top of the world, as the most favorable geographic center in Asia for such an event, we may have hopes of finding the remote ancestors of man in this section of the country. However, this Mongolian idea must be treated only as an opinion; it is not yet a theory, but the opinion is sufficiently sound to warrant further extended investigation.

No pro-human habitat could present a wider contrast than does the central Asiatic plateau to Darwin's "warm, forest-clad land." All recent ethnologic and physiographic evidence points in the same way, namely, that intelligent progressive and self-adaptive types of mankind arise in elevated upland or semi-arid environments where the struggle for food is intense and where reliance is made on the invention and development of implements as well as

<sup>3</sup> H. F. Osborn: "Why Mongolia may be the Home of Primitive Man." *The Peking Leader*, October 10, 1923.



weapons. On the contrary, there is no premium on invention, intelligence, or self-adaptation in mammals of any kind living in warm forests.

Granting all the very strong *circumstantial* evidence in favor of the ape-man theory, which has been piled mountain high by investigators since the time of Darwin and has been recently revived and stimulated to new force by the attacks of the fundamentalists on the whole evolution theory, we must look for the direct evidence which can come only from geology and palaeontology. The final solution of this problem of problems therefore rests with the fossil hunter and explorer, whose task is an extremely difficult one because fossil remains of Primates, always scarce, are becoming increasingly scarce as the Primates rise in the scale of intelligence. I do not know the exact figures, but I think it is safe to say that 50,000 to 1 is about the ratio of probability of discovery of fossil remains of lower orders to fossil remains of Primates in Tertiary time.

Meanwhile, the circumstantial evidence of geology and of geography is all in favor of the theory that the pro-man stock was well established in Oligocene time, now conservatively estimated at sixteen million years ago. At this time occurred the first *modernization* of the entire mammalian kingdom. So far as we can observe geologically, this modernization was due to the first great wave of aridity concurrent with the complete elevation of great continental plateaus, especially in central Asia and in the western region of North America.

This wave of aridity and of elevation caused a profound cleavage in the mammalian world, the first great natural divorce between the warm forest-loving types developed during the preceding Eocene period and the temperate plains and plateau-loving types which apparently invaded the great Oligocene belt of the 40th parallel from the north. This cleavage profoundly affected the whole mammalian world of this region; not only the horses, rhinoceroses, tapirs, and even-toed animals like the progenitors of the deer, the cattle, and the camel families had to make their choice between forest regions and the plains, but the carnivorous enemies—wolves and foxes and the progenitors of the greater carnivores in the cat family—were compelled to go forest-ward or plains-ward. It is not at all probable that the Primates—lemurs, North and South American monkeys and the hypothetic division of pro-man—were exempt from this compelling and fateful decision. Why was it postponed by the progressive progenitors of man when adopted by all the progressive elements in the remaining mammalian world? Why theoretically postpone this fateful decision on the part of our primate ancestors to Miocene or Pliocene time, as is

still done by many conservative writers who continue to adhere to the abandoned conceptions of the period of Charles Darwin's speculation partly because of loyalty to him and reverence for his classic contribution to anthropology?

This concludes the seventh address which I have devoted to this absorbing subject. In the succeeding or eighth address I shall continue the attack and try to demonstrate that while the anatomical and embryological evidence for the *kinship* of the apes to man is overwhelming, the same evidence, when closely analyzed and subjected to conditions of modern principles of phylogeny discovered since Darwin's time, compels us to replace the ape-man hypothesis by the new pro-Dawn Man theory.

HENRY FAIRFIELD OSBORN

### THE USE OF CHARTS IN THE NATURAL SCIENCES

OLD teachers of natural science subjects will remember the time when charts were used extensively in classroom and laboratory instruction. That was before the general introduction and universal use of the lantern, now the principal means of classroom demonstration. The lantern slide has almost completely driven out the chart, and many university departments of zoology, anatomy, physiology, bacteriology and botany have practically no charts at all, or whatever they have is antiquated material or home-made, crude and unattractive.

A recent inspection of new German charts suggested the question whether we have not gone too far in our abandonment of the use of the chart and have deprived ourselves of a help, which the lantern-slide can not and will not render. In Germany it was undoubtedly the reason of economy which prompted the continuous use of charts instead of slides. Under present circumstances no German university institute could afford to equip each classroom with a lantern or to have enough portable lanterns on hand to put one at the disposal of each lecturer or laboratory instructor. Of course there are some lanterns in German universities, but they are few and far between. The same is true to a still higher degree of French educational institutions. Also, the high perfection in graphic arts in Germany and the comparatively low cost of publishing charts of a high artistic value have contributed in a large degree to the universal demand for charts in German classrooms.

Sometimes the lantern-slide is superior to the chart. It allows a much greater variety of illustrations. It is handy to use and every biological laboratory has the equipment to make lantern-slides from



micro-photographs, from field-photographs, from book illustrations and drawings. The costs are comparatively low, and it is easy to build up a collection of thousands of slides in the course of years. When the classroom is darkened and the lantern in operation, it is easy to run through a series of sixty to seventy-five slides during a classroom period of one hour. But there is one great disadvantage connected with this form of instruction. It invites haste and superficiality and the attention of the student is purely voluntary and frequently very inadequate. He looks upon the lantern-slide demonstration as an entertainment which he may follow or not. Since he can not take any notes in the dark classroom and can make no drawings from lantern-slides, he has no record and he knows that he can not be examined about the material shown in this way. He is also deprived of a chance to review these pictures at his convenience after class. Also the lantern-slide can never be used for laboratory purposes, since a continuous comparison between object and picture is impossible. In spite of these drawbacks the lantern-slide will undoubtedly continue to hold its place as a means of convenient and rapid demonstration.

Where the lantern-slide fails, the chart can take its place to greater advantage. If charts are used in a class, the student can make notes of the lecture and if he has enough time he can accompany these notes by drawings. If the charts are left in the room, the student may use them for additional notes, drawings and reviews after recitation. Charts can be exhibited in a laboratory and left there during the entire laboratory period and the student can constantly compare what he sees in the microscope or what he has on his dissecting table with the information supplied by the chart. Good charts will emphasize certain features of an object and omit details which make a photographic picture frequently less lucid. Also, the charts can picture objects of which photographs are hard or impossible to obtain and maybe the results of a teaching experience which is not available for many instructors. These are sufficient reasons to suggest a revision of our present abandonment of charts and to consider seriously whether departments of zoology, botany, physiology, anatomy, general biology, not to mention geography and geology, should not give very serious attention to charts, as means of rounding out their equipment for illustrative material.

Of the many new charts which have recently been published, mostly in Germany, a few of the outstanding sets will be discussed in the following.

In the field of general biology should be noted Haecker's *Wandtafeln zur allgemeinen Biologie*.

Among other subjects they illustrate Mendel's law, the De Vries' theory of mutation, also the protective coloring of insects and the influence of temperature on insect colors. Matzdorf's *Lebensbeziehungen und Gewohnheiten der Tiere* shows the effects of mimicry in animals and their different habitats. The life of protozoa is illustrated in Täuber's *Mikroskopische Wandtafeln*.

In zoology the front rank is still held by Leuckart and Nitsche's *Zoologische Wandtafeln*. This large series has one hundred sixteen large-sized charts and covers the whole ground which may be taken up by any general zoology course dealing with invertebrates. These charts are masterpieces of accuracy and scientific detail and supply inexhaustible material for laboratory study.

Among the other charts in general zoology two main groups may be observed, one in which the animals are pictured detached and without reference to biological features, like habitats or ecologic relation to man, and the other where the animal is considered as part of its natural surroundings. The first group is represented by such collections as Jung, Koch and Quentel's *Neue Wandtafeln für den Unterricht in der Naturgeschichte*, Schroeder and Kull's *Biologische Wandtafeln zur Tierkunde*, Pfurtscheller's *Zoologische Wandtafeln*, or Engleder's *Wandtafeln für den naturkundlichen Unterricht (Tierkunde)*. There is another group as mentioned above which pictures the animals with their natural background. These charts are mostly of high artistic value, having been executed by painters of ability following the advice of scientists. Many of these charts are so beautiful that they could be used for decorative purposes and might find permanent places in museum rooms, classrooms and corridors. Here should be mentioned Täuber's *Zoologische Wandbilder*, Schmeil's *Zoologische Wandtafeln*, and Lehmann-Leutemann's *Zoologischer Atlas*. For instruction in animal anatomy should be mentioned Brass-Lehmann's *Zootomische Wandtafeln* and Täuber's *Zootomische Wandtafeln*.

A very attractive series of instruction in embryology and histology is represented by Smalian's *Histologische embryologische Tafeln*.

Among various entomological charts may be mentioned Schlüter's *Schädlingstafeln der Deutschen Gesellschaft für Angewandte Entomologie*. On fourteen charts the most important harmful insects are given in relation to their human and plant hosts. Another interesting set describing entomological objects are Meinhold-Pascal's *Biologische Charakterbilder der Niederen Tiere*. This set of seventeen charts deals with representative types without reference to harm-



fulness and shows them in their natural surroundings and activities.

For bacteriology two sets of charts have been published by F. Lucksch. Series I shows the general forms, structure, sheaths and cilia of bacteria. Series II deals with pathogenic bacteria.

The best set of charts ever produced on human anatomy are unquestionably the American Frohse Life-Size Anatomical Charts. These eight charts are the most valuable means of instruction in human anatomy and are known to all medical men. A smaller set along the same lines is formed by Zschommler's Buntfärbige Röntgenbilder, in which the human body is pictured as if seen transparent. In this way the bones and softer organs can be seen in their natural relation to each other. The set consists only of two charts and gives the front and rear view of the body. Other sets of charts dealing with human anatomy are Fiedler and Hoelemann's Anatomische Wandtafeln and K. G. Lutz's Anatomische Wandtafeln. There is also a French series of charts, the Deyrolle, on human anatomy, but it does not compare in any way with the American or German publications.

It is especially the science of botany where the German charts excel, although a slight disadvantage is the difference in species which characterizes the North American and the German floras. This difference is not large enough to form a serious handicap for the use of the foreign charts, since a great many species are common or internationally known.

The most important series in general botany are L. Kny's Botanische Wandtafeln. The former is a set of 120 charts and represents an extensive botany course in itself. Its complete study would take at least a year for any beginning class in botany, but many of these charts could also be used in various advanced courses dealing with anatomy or morphology of plants. The manual which is published with these charts covers 563 octavo pages of German text. Other large sets illustrating botany are Balslev-Warming's Botanische Wandtafeln and Engleder's Wandtafeln für den naturkundlichen Unterricht, Pflanzenkunde. The two last-mentioned sets do not deal with general botany but are more or less useful for courses in local floras and in plant taxonomy. A very beautiful set of charts illustrating the principal tree types are Hartinger's Wandtafeln: Bäume. The set pictures on twenty-five charts the most important tree types of the temperate zones. The execution of the charts is so beautiful that every one of them could be used for exhibition. They give the local background and natural setting of the trees.

The modern botanical subject of plant ecology is well represented in Potonié-Gotham's Vegetationsbilder der Jetzt- und Vorzeit. Six of these charts deal with the different ecologic types of modern vegetation as climax forest, swamp vegetation, mural flora, alpine flora, prairie vegetation and high moor flora. Two other charts are reconstructions of ancient floras and are unique in their way, being devised by men who were thoroughly familiar with plant paleontology and executed by prominent artists. One of these two charts represents a late Paleozoic swamp forest from the coal age while the other chart pictures a Mesozoic forest probably from the Jurassic period. The Potonié-Gotham charts are 50 x 38 inches and their size makes them highly acceptable for decorative purposes in classrooms and museums. A number of sets are devoted exclusively to the subject of plant anatomy. Among these is most complete the collection of Frank and Tschirch's Wandtafeln für den Unterricht in der Pflanzenphysiologie. This set pays special attention to plant anatomy from the viewpoint of physiology. A much smaller series containing only eight charts brings out some of the most important data of plant anatomy as different types of cells and tissues.

There are two well-known sets dealing with the subject of plant pathology, one in French and one in German. The first one is Fron's *Maladies des Plantes Cultivées et leur Traitement*. It contains only a limited number of charts dealing with important diseases of agricultural plants. A much more complete treatment of the same subject is found in Appel-Riehm's *Atlas der Krankheiten der Landwirtschaftlichen Kulturpflanzen*. This collection of rather small charts ( $11\frac{1}{2} \times 17\frac{1}{2}$ ) commends itself not only for classroom purposes but also as a laboratory text-book and field guide. The illustrations are excellent and picture the different diseases of cereals, vegetables, fruit and seed plants.

There are several sets of charts dealing with foreign useful plants, mostly tropical. Since the charts are published in Germany, the American cotton and tobacco figure amongst the foreign plants. One series of charts along these lines is Zippel's *Ausländische Kulturpflanzen*. There are sixty-seven charts divided into three series in the set, and the plants are shown on black background with analytic drawings of various organs as insets. Another series on the same subject is Goehring-Schmidt's *Die wichtigsten ausländischen Kulturpflanzen*. The charts of this series show the plants in their natural setting and with their human relations and therefore are also valuable for geographic instruction. The coloring and design are very beautiful. Apparently the

Goehring-Schmidt charts have been drawn from first-hand information because all details with regard to plantations, to natives and to the preparation of plant products are true to nature and not made from imagination. The entire series is one of the most attractive sets of charts that has ever been produced.

Recently a number of geological and paleontological charts have come to the writer's attention. Very useful for the teaching of historical geology are Lindner's Wandtafel zur Erdgeschichte. The chart summarizes the principal facts of earth history and can be used not only for an introductory lecture but would also be valuable for permanent use during such courses in zoology and botany where constant reference to geologic epochs must be made. It is a chart which the students should carefully study provided that they know enough German to understand a limited number of geologic terms. The chart is divided in columns which deal with the different epochs and their subdivisions, with the distribution of sedimentary and igneous rocks in geologic time, with the history of structural changes, climates and organic developments, and with the varying distributions of land and water during the earth's history.

An attractive set of charts on paleontology is Fraas' Die Entwicklung der Erde und ihrer Bewohner, in seven colored charts, representing the most important epochs in the history of the earth. Each chart contains in its upper part a reconstruction of the principal animal and plant types arranged in an ideal landscape picture, with a legend in the left-hand upper corner, while the lower half of the chart shows the geologic profile of the rock formation on the right side, and a plate with index fossils of the respective period on the left side. The ideal landscape represents merely life at a given moment during the formation in question, but the profile generalizes the geologic sections through all important horizons of the entire period. Therefore the profiles of the different charts, taken together, give a continuous sequence of the geologic deposits through the earth's crust. It is obvious that this series would prove not only useful in introductory courses in the earth's history but would be very profitable for a short series of historical lectures connected with courses in evolution.

Physiography is a subject which leads from geology into geography. It is well represented in a series of charts by Fraas, Die Naturerscheinungen der Erde. The charts deal with the phenomena and the effects of volcanic action, the mechanical forces of water and air, the rôle which ice is playing to-day on the surface of the earth and with such physiographic character types as the prairie, the coral reef, and the desert.

There are numerous charts devoted to the teaching of geography, especially human ecology. Let us select as a representative series for this discussion Wünsche's Land und Leben. In forty beautifully executed pictures, scenes from cities, harbors, rivers, primitive forests, jungles, prairies, all over the world are shown, with groups of people in their peculiar activities. There is an immense geographic information accumulated in these pictures which seem to have all been prepared by artists on the basis of first hand knowledge. They all look so real and are in no way a product of imagination or second-hand information.

With the exception of one set which is American, and two sets which are French, the charts mentioned in this article are all "made in Germany." They are well executed in colors, in high type of German graphic workmanship. Each set is accompanied by a manual written in Germany and only in very few instances this manual contains an English and French translation. The fact that the manual is written in a foreign language is unquestionably a disadvantage, but it also reminds the American scientist that he can get only the full benefit of the world's treasure of information if he is able to read German with sufficient fluency. There seems to be no escape from this fact in spite of the idea which sprang up during the Great War that the German language can be counted out of the necessary equipment of a scientist. At least it won't be true as long as the Germans continue to publish information of general usefulness.

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## SCIENTIFIC EVENTS

### AN INTERNATIONAL COMMITTEE FOR RESEARCH ON INFANTILE PARALYSIS

AN international committee for the study of infantile paralysis has recently been formed under the chairmanship of Dr. W. H. Park, director of the bureau of laboratories of the New York City Health Department. Arrangements have been made for a concerted three-year attack on the difficult problems of prevention and therapy presented by this formidable and crippling disease. To enable research to be conducted at a number of centers in the United States and in Europe, a sum of \$250,000 has been contributed by Mr. Jeremiah Milbank, a New York financier, who takes an active personal interest in hospitals and charities. The following centers have been chosen for the proposed researches: Bureau of Laboratories, New York City Health Department; the pathological laboratories of Columbia, Harvard and Chicago Universities; the Pasteur Institute, Brussels, and the Lister



Institute, London. These various institutes are represented on the international committee by their respective heads. The personnel of the committee is as follows: *Chairman*, Dr. W. H. Park; *vice-chairman*, Dr. Joseph A. Blake, of Tarrytown, N. Y.; Drs. E. O. Jordan and Ludvig Hektoen, of the University of Chicago; Drs. F. P. Gay and Frederick Tilney, of the College of Physicians and Surgeons, Columbia University; Drs. Milton J. Rosenau and Hans Zinsser, of Harvard University; Dr. Lee K. Frankel, of the Metropolitan Life Insurance Company; Sir Charles J. Martin, of the Lister Institute, London, and Dr. Jules Bordet, of the Pasteur Institute, Brussels. Mr. Samuel M. Greer and Dr. Josephine N. Neal will act, respectively, as treasurer and secretary, and the committee's headquarters will be Dr. Park's office at the Bureau of Laboratories, East 16th Street, New York, N. Y. Directors of research at each selected center will be free to initiate such investigations as seem to them desirable and within the compass of their respective institutions. The results of such researches will, however, be studied and coordinated by the international committee, and will thus constitute a joint piece of work. At the Lister Institute special arrangements are being made for research on poliomyelitis under the direction of Professor J. C. G. Ledingham.

#### DEDICATION OF THE SANTA CATALINA NATURAL AREA

ON May 12, 1928, the Santa Catalina Natural Area, near Summerhaven in the Santa Catalina Mountains of southern Arizona, was dedicated by the Tucson Natural History Society and representatives of the United States Department of Agriculture.

The area lies at an elevation range of from 4,800 to 9,150 feet and includes 4,464 acres. It embraces the summit of Mount Lemmon, Marshall Gulch (where the Desert Laboratory of the Carnegie Institution of Washington has several experimental plots), the Wilderness of Rocks and a considerable part of the headwaters of Lemmon Creek. It contains samples of nearly all the ecologic communities represented in the higher parts of the mountains.

The dedication is the result of a movement initiated several years ago by the Tucson Natural History Society. After a period of investigation by the society's committee on preservation of natural areas and by officials of the Forest Service, the matter was taken up with the forester and the Secretary of Agriculture in Washington. On March 3, 1927, favorable decision was made by the secretary.

Administration and management of the area is to be by the Forest Service. Regulations applying to the tract have been worked up jointly by the society and the service.

The dedicatory program was opened by Dr. Chas. T. Vorhies, of the University of Arizona. Assistant District Forester John D. Jones, of Albuquerque, New Mexico, explained the Forest Service policy, adopted by the forester on December 30, 1926, providing for five categories of tracts: (1) Wilderness areas, more than 500,000 acres; (2) semi-wilderness areas, 25,000 to 250,000 or 300,000 acres; (3) natural areas, 320 to 4,000 or 5,000 acres; (4) scenic areas, of varying size; (5) scenic strips, along selected highways. These areas are planned to care for different phases of the scientific and recreational needs of the people.

Other speakers on the program included G. A. Pearson, director of the Southwestern Forest Experiment Station, Flagstaff, Arizona, and Dr. Walter P. Taylor, of the U. S. Biological Survey.

The dedicatory program was concluded by the exhibition, in the lobby of La Mariposa Hotel, Summerhaven, of five reels of motion pictures, through the courtesy of the Forest Service and Mr. J. D. Jones. These were "Forest and Waters," "Horses and Men" and "Trees of Righteousness."

The committee in charge of the dedication was A. A. Nichol, secretary of the Tucson Natural History Society, *chairman*; Chas. T. Vorhies, of the University of Arizona, and Fred Winn, supervisor, Coronado National Forest.

#### RESEARCHES AND PUBLICATIONS OF THE PRINCETON UNIVERSITY EXPEDITIONS TO PATAGONIA—1896-1899

At the recent meeting of the American Philosophical Society, Professor William Berryman Scott reported on the imminent completion of a very great scientific undertaking begun in 1896. The publication of reports of Professor Scott's work in Patagonia between the years 1896 and 1899 was originally rendered possible through the interest and generous donations of the late J. Pierpont Morgan, supplemented by gifts from the Carnegie Institution and Princeton University. In recognition of the high scientific value of this work, Professor Scott has been awarded the Wollaston medal by the Geological Society of London. Professor Scott's informal statement of the progress of work is as follows (*H. F. O.*):

Like everything else in connection with the Princeton Patagonian expeditions, the plan of the series of reports was due to Mr. J. B. Hatcher, the leader of the explorations. So great were the collections in all departments of natural history, that he felt it would be a great misfortune to have the results scattered through many publications—journals and transactions and proceedings of learned societies; and he therefore proposed to me that I should endeavor to finance the independent publication



of these remarkable results. The late Mr. J. Pierpont Morgan gave me \$24,000 for the work; and, so far as could be foreseen at that time (1900), this sum should have been sufficient, as the plan called for only eight quarto volumes. Unfortunately, however, every contributor far exceeded his estimates as to the amount of text and the number of plates which he would require, and the nominal eight volumes have expanded to fourteen. The additional sums necessary for the publication have been obtained partly from the Carnegie Institution of Washington (\$1,500) and Princeton University (\$6,000), and from sales of the work to subscribers.

Volume I contains the narrative of the expeditions and the geography of Patagonia by Mr. J. B. Hatcher, whose untimely death prevented his taking any further part in preparing the Reports.

Volume II (Ornithology) was mostly written by the late Messrs. W. E. D. Scott, of Princeton, and R. B. Sharp, of the British Museum, both of whom died in 1910, leaving that volume unfinished. Their remaining manuscript was taken by Dr. Witmer Stone, of the Philadelphia Academy of Natural Sciences, and the final part was entirely written by him.

Volume III (Zoology) is due to a number of hands. The late Dr. J. A. Allen, of the American Museum of Natural History in New York, wrote the chapters on the Mammals; Dr. L. Stejneger, of the U. S. National Museum, prepared those on the Reptiles and Amphibia; the late Dean Eigenmann, of the University of Indiana, wrote the report on Fishes; the late Dr. A. E. Ortmann, formerly of Princeton and then of the Carnegie Museum in Pittsburgh, reported on the Crustacea; Professor Calvert, of the University of Pennsylvania, wrote that part on the Leeches, and Professor Moore, of the same institution, was also a contributor.

Volumes IV to VII, inclusive, were devoted to paleontology. Volume IV contains the reports of Dr. T. W. Stanton, of the U. S. National Museum, on the Cretaceous Invertebrates, by Dr. Ortmann on the Tertiary Invertebrates, and finally the report by Dr. W. J. Sinclair, of Princeton, on the Marsupials of the Santa Cruz formation. Volume V was entirely written by myself, and contains the descriptions of the Edentata and Glires (Rodentia) of the Santa Cruz. Volume VI has Dr. Sinclair's chapters on the Santa Cruz Typotheria, and mine on the Toxodontia and Entelonychia. The remaining part of this volume, my report on the Astrapotheria and the monkeys in the Santa Cruz, is now in the printer's hands, and will, I trust, appear in a few weeks. Volume VII contains my chapters on the Litopterna. Dr. M. S. Farr, of Princeton, is preparing the report on the fossil birds of Patagonia, and that will go to the printer as soon as the Astrapotheria are completed. And, finally, is a brief summing up of the Santa Cruz fauna and the Patagonian geology by myself. This will contain nine plates in heliotype reproduction of Mr. Charles Knight's restorations of Santa Cruz mammals, plates which are now being made in Boston by the firm of E. O. Cockayne. I am particularly glad to publish these restorations, because of the great interest which Mr. Morgan took in

them. One of the first things he said, on agreeing to furnish the funds, was that we should immediately turn to Knight for a series of restorations.

Volume VIII, and a supplementary volume, are devoted to botany. The great bulk of this *Flora Patagonica* was prepared by the late Professor George Macloskie, of Princeton, with the most valuable criticism and assistance of the eminent Swedish botanist, Per Dusen, who also wrote the chapters on the Patagonian mosses. The report on the Hepaticae was written by Professor Evans, of Yale University.

I can already give a very close approximation to the number of pages of text and of plates which the finished work will contain, as all the plates are either finished, or in the hands of the engravers. The great majority of the plates are lithographs, which were made by the firm of Werner and Winter, of Frankfurt, in Germany; but some photographic processes were made in this country, partly in New York, and partly in Boston. The water color drawings for the modern birds were done by Mr. Keulemans, who was so long associated with Dr. Sharp in the work of the British Museum. The botanical plates were mostly prepared in London, as Dr. Macloskie, through his connections there, was able to exercise a closer supervision than he could have done in Frankfurt. The total number of pages of text is approximately 4,880, of a preliminary text cvii, and of plates 421, of which latter 37 are colored. Much of the value of the work is derived from its admirable plates and for these the original drawings were principally made by the late M. von Itenson and Bruce Horsfall. The work of Messrs. Knight and Keulemans has already been mentioned.

In this country there are about 100 subscribers, and in addition there are a number of free and exchange copies. I have, as yet, had no report from the European publishers at Stuttgart.

The long delay in the completion of the work has been due partly to the war, and partly to the period of extravagant prices which followed. This inflation affected especially everything connected with the making of books, having more than doubled the cost per unit of the parts which remained to be issued after the war. The end is now in sight; and I can not but esteem myself fortunate in having been able to see the great work thus far on its way.

#### REORGANIZATION OF THE DEPARTMENT OF ZOOLOGY AT COLUMBIA UNIVERSITY

COLUMBIA UNIVERSITY has announced plans to develop the department of zoology. These include the appointment of Dr. Leslie Clarence Dunn, of the Agricultural Experiment Station at Storrs, Conn., and James Gray, of the University of Cambridge, England, to carry on the experimental work in genetics. This program of expansion also embraces broadening of research, creation of a new professorship and a new lectureship, reorganization of courses, enlargement of equipment and, ultimately, the construction



of laboratories for the biological sciences rivaling those recently provided for physics and chemistry.

Dr. Edmund B. Wilson, Da Costa professor of zoology and executive officer of the department, who has been at Columbia for thirty-seven years, will retire from active service on July 1 with the rank of professor emeritus in residence. With President Henry Fairfield Osborn, of the American Museum of Natural History, he organized the department of zoology at Columbia in 1891. Professor Wilson will continue to conduct research at the university, and will be available for consultation and advice by advanced students. He will not, however, offer any stated instruction leading to a degree. As previously announced, Professor T. H. Morgan will leave the university in July for the California Institute of Technology, at Pasadena, Calif., where he will be the head of the division of biological sciences.

Dr. Gary N. Calkins, who holds the professorship of protozoology, will succeed Dr. Wilson as executive head of the department.

Dr. Dunn, who will occupy the new professorship of zoology, was born in Buffalo, N. Y., in 1893, and was graduated from Dartmouth College in 1915. He pursued advanced studies at Harvard University, taking the degree of doctor of science in 1920. For four years he was assistant in zoology at Harvard.

Mr. Gray, the new lecturer in zoology, is now lecturer in zoology at King's College, Cambridge. He is well known in the younger British group in zoology. He is thirty-eight years of age and was trained at Cambridge, where he received the degree of A.B. in 1912 and A.M. in 1916. Mr. Gray will lecture on experimental zoology and embryology. His researches have been in the field of experimental embryology and cytology, including researches on artificial parthenogenesis, cell division and the development of the lower animals.

## SCIENTIFIC NOTES AND NEWS

BOTH branches of Congress have adopted a resolution providing for the striking of a gold medal commemorative of the achievements of Thomas A. Edison and the presentation of the medal to Mr. Edison by congress. Duplicate medals in bronze are to be made and sold at cost.

GOLD medals will soon be presented, under authority of an act of Congress just approved by President Coolidge, to Lincoln Ellsworth, Umberto Nobile and Roald Amundsen in recognition of their joint transpolar flight in the dirigible *Norge*.

CAPTAIN WILKINS, who with Lieutenant Eielson recently flew from Alaska to Spitzbergen, was

awarded the Carl Ritter medal by the centenary session of the Geographical Society on May 24.

THE Imperial Order of the Second Class of the Rising Sun has been conferred by the Emperor of Japan upon Dr. Hideyo Noguchi, the discoverer of the yellow fever germ, who died May 21 while conducting investigations for the Rockefeller Institute on the Gold Coast of Africa.

IN recognition of his work in the study of nephritis, Dr. Thomas Addis, of the Stanford Medical School, has been awarded the Gibbs memorial prize of \$1,000. He will devote it to the Wellington Gregg fund of the school, through which research work in this disease is being financed.

DR. DAVID RIESMAN, professor of clinical medicine at the University of Pennsylvania School of Medicine, was recently made a Knight of the Order of the Crown of Italy.

FREDERICK E. BRASCH, of the Library of Congress (Smithsonian division), has been awarded a grant for research from the American Council of Learned Societies to complete his studies upon the history of astronomy during the Colonial period in the United States.

THE research prize awarded by the Scientific Club of Winnipeg for the best research work done in the University of Manitoba during a period of three years by a recent graduate has been divided between Leonard B. Clark and Charles F. Goodeve, whose work was carried on in the departments of zoology and chemistry, respectively.

DR. W. REID BLAIR, director of the New York Zoological Park, has had conferred upon him on May 28 by McGill University the honorary degree of doctor of laws.

DR. ABRAHAM FLEXNER has resigned as director of Studies and Medical Education of the General Education Board.

PROFESSOR ARTHUR E. SEAMAN, head of the department of geology in the Michigan College of Mining and Technology, is retiring after forty years of service. Dr. C. O. Swanson, of the Michigan Geological Survey, will succeed Professor Seaman.

DR. T. T. QUIRKE, chairman of the department of geology at the University of Illinois, has been relieved of his administrative duties and will continue his work at the University of Illinois as professor of geology. During the summer he will continue his field researches which he has been carrying on for several years in the Precambrian complex north of Lake

Huron. Professor W. S. Bayley has been made head of the department at the university.

DR. LYNN THORNDIKE, professor of history at Columbia University, was elected president of the History of Science Society by the council, to fill the unexpired term of Dr. Edgar Fahs Smith, who died on May 3.

PROFESSOR H. B. DWIGHT, of the Massachusetts Institute of Technology, was elected chairman of the Boston section of the American Institute of Electrical Engineers at the annual meeting.

DR. W. H. ECCLES, F.R.S., has been elected president of the British Physical Society.

CLARK C. HERITAGE, of the Paper Board Corporation, has been appointed to the position of senior chemical engineer in charge of the section of pulp and paper of the Forest Products Laboratory at Madison, Wisconsin, succeeding John D. Rue, who recently resigned.

DR. J. A. LECLERC, grain specialist in the foodstuffs division of the U. S. Department of Commerce, has accepted appointment in the food research division of the chemical and technological research unit of the Bureau of Chemistry and Soils.

H. S. BEAN, chief of the gas measuring instrument section of the Bureau of Standards, will take charge of the cooperative investigation in Buffalo, of the Bureau of Standards, the Bureau of Mines and the Natural Gas Department of the American Gas Association, on methods for measuring large volumes of gas.

DR. CLAUDE FULLER, formerly chief entomologist of the Union of South Africa, has left Pretoria for Lourenco Marques, where he will assume the duties of chief entomologist to the government of Mozambique.

UNDER the direction of Dr. Johannes Schmidt, of Copenhagen, a scientific expedition, chiefly financed by the Carlsberg fund, is leaving Denmark at the beginning of June on a journey around the world. The object of the expedition is to carry out oceanographic and zoological investigations, more especially regarding the species of eel in the Pacific and it is expected to take two years.

DR. ELIAS MELIN, soil botanist of the Swedish College of Forestry, Stockholm, has spent the last year visiting and studying at various agricultural experiment stations in the United States.

DR. J. C. TH. UPHOF, head of the department of botany at Rollins College, will be connected during the coming summer with the Tropical Plant Research Foundation in Washington, D. C., to prepare reports on sugar cane growing and sugar technique of the Dutch East Indies.

PROFESSOR KIRTLEY F. MATHER, head of the department of geology at Harvard University, will lead a party of geological students into the Swiss Alps this summer. On reaching Switzerland the group will combine with a party headed by Dr. L. W. Collet, professor of geology in the University of Geneva.

SAMUEL J. RECORD, professor of forest products in the school of forestry of Yale University, sailed for Europe on June 2 to enlist the cooperation of scientists there in a comprehensive investigation of the forest resources of the tropics, and particularly of western Africa. The trip is sponsored by Mr. Harvey Firestone, president of the Firestone Rubber Company, Akron, Ohio.

DR. A. S. HITCHCOCK, custodian of grasses in the U. S. National Museum, will leave for Newfoundland about July 1 to collect grasses.

DR. W. F. BOOK, chairman of the department of psychology and philosophy in Indiana University, returns on June 10 from a tour around the world. He will resume his work at Indiana in September. Dr. Geo. S. Snoddy was acting chairman of the department in Dr. Book's absence.

JAMES L. PETERS, research associate in ornithology in the Museum of Comparative Zoology at Harvard University, and Edward Bangs recently returned from a collecting trip in Central America. In all, some six hundred birds were added to the collection in the museum.

DR. WILLIAM S. THAYER, of the Johns Hopkins University, president-elect of the American Medical Association was a delegate to the Harvey Tercentenary celebration in London in May.

DR. R. J. TILLYARD, commonwealth entomologist of Australia, and Mr. J. W. Evans, one of his assistants, visited the Kansas State Agricultural College on May 19 to 22. On May 20, a special field meeting of the Kansas Entomological Society occurred at the fossil beds at Elmo, Kansas. On May 21, Dr. Tillyard addressed the zoological and entomological seminar on the subject of "The Relation of the Study of Fossil Insects upon Insect Evolution."

PROFESSOR C. U. ARIENS KAPPERS, director of the Central Institute of Brain Research, Amsterdam, is giving a series of six lectures in the neurological department of Columbia University at the new medical center from June 4 to 9 at 4:00 P. M.

DR. F. D'HERELLE, of Alexandria, Egypt, who is to give the Lane lectures at Stanford University during the week beginning October 22, will address a joint meeting of the Chicago Society of Internal Medicine and the Institute of Medicine of Chicago in October.



DR. GEORGE BARGER, professor of medical chemistry at the University of Edinburgh, now lecturing at Cornell University, addressed a meeting of the New York section of the American Chemical Society, the American Electrochemical Society, the Society of Chemical Industry and the Société de Chimie Industrielle on June 1, when he spoke on "Thyroxine and the Thyroid Gland."

DR. RAYMOND PEARL, director of the institute for biological research of the Johns Hopkins University, lectured at Cornell University on May 9, on the Schiff Foundation, on "Experiments on Longevity," and on May 10 and 11 he delivered the eleventh series of Harrington lectures at the University of Buffalo Medical School, the subjects being, "Alcohol and Life Duration" and "Cancer from the Viewpoint of the Human Biologist."

DR. DONALD C. BARTON, of Houston, Tex., consulting geologist and geophysicist, recently gave a series of lectures on certain phases of oil geology and geophysics at the University of Chicago, at the Massachusetts Institute of Technology and at Harvard University.

THE Hermann M. Biggs Memorial Fund has given more than \$55,000 to New York University to establish a professorship in preventive medicine in Dr. Biggs's name in the medical college.

THE Louis Agassiz Fuertes memorial room in Ithaca was opened May 28 to the public. The room contains a collection of memorabilia of Dr. Fuertes, including three thousand five hundred birds which he used for his working models in his illustrations and paintings.

THE display of works, illustrations and other data, marking the tercentenary of Harvey's discovery of the circulation, is now open to visitors at the New York Academy of Medicine. The collection of loan specimens occupies eleven cases in the main reading hall.

At the thirty-seventh annual general meeting of the British Institution of Mining and Metallurgy in London, Mr. Peter Larkin, High Commissioner for Canada, presented to the institution a portrait of the late Dr. Willet G. Miller, provincial geologist of Ontario. The portrait, which is a replica of the original now hanging in the Ontario Legislative Buildings, is the gift of Canadian friends and admirers of the late Dr. Miller.

WILLIAM H. NICHOLS, JR., vice-president of the Allied Chemical and Dye Corporation, known for his work on the metallurgy of copper, died on May 28, aged seventy-six years.

DR. W. M. L. COPLIN, emeritus professor of pathology and bacteriology in the Jefferson Medical College, died on May 29, aged sixty-three years.

PRESS dispatches announce the death from yellow fever of Dr. William Alexander Young, director of medical research at Accra, on the African Gold Coast. Dr. Young was working with the late Dr. Hideyo Noguchi on yellow fever.

DR. JOHN HORN, the well-known geologist of Scotland, has died at the age of eighty years.

DR. H. F. GADOW, Strickland curator and reader in morphology of vertebrates in the University of Cambridge since 1884, died on May 16, at the age of seventy-three years.

DR. ARTHUR HERBERT LEAHY, emeritus professor of mathematics at the University of Sheffield, died on May 16, aged seventy years.

DR. EMIL FROMME, professor of chemistry at the University of Vienna, died on May 29, at the age of sixty-three years.

THE thirteenth International Physiological Congress will be held from August 19 to 23, 1929, at the Harvard Medical School, Boston. This congress meets for the first time in the United States, and is to be under the auspices of the Federation of American Societies for Experimental Biology.

FORTY-FIVE geologists from Iowa, Nebraska, Missouri, Kansas, Arkansas, Oklahoma and Texas met in conference at the offices of the Oklahoma Geological Survey at Norman on May 19 for a discussion of the problem of the Pennsylvanian of the western interior region. Dr. Raymond C. Moore was elected chairman of the conference. After much profitable discussion, it was decided that a general committee be appointed to outline methods for the solution of the Pennsylvanian problem. It was voted to work in conjunction with the American Association of Economic Paleontologists and Mineralogists.

LEADERS in the field of oil engine power, manufacturing, operation and research will convene at the Pennsylvania State College on June 14, 15 and 16 for the first national meeting of the oil and gas power division of the American Society of Mechanical Engineers and the second annual oil power conference arranged by the Pennsylvania State College. Developments in the Diesel engine in all parts of the world will feature the discussions. Among the speakers who will discuss technical phases of the industry are Charles M. Schwab, former president of the society, and George Heath, of the Carels corporation of London, England. The Atlantic division of the American

Relay League will hold its third annual convention on the same dates.

FREE public lectures will be given at the New York Botanical Garden on Saturdays during June and July at 4:00 P. M. as follows: June 2, "Japanese and Siberian Irises," Dr. George M. Reed; June 9, "A Naturalist in India, Kashmir and Burma," Mrs. Barnum Brown; June 16, "Life Zones of the Rocky Mountains," Dr. P. A. Rydberg; June 23, "Roses," Mr. F. L. Atkins; June 30, "Botanical Rambles in Panama," Dr. Marshall A. Howe; July 7, "The Story of the Redwoods," Dr. Arthur Hollick; July 14, "Wild Flowers," Mrs. N. L. Britton; July 21, "Selecting a National Flower," Dr. Edgar T. Wherry; July 28, "Fungous Diseases of Plants," Dr. B. O. Dodge.

THE U. S. Civil Service Commission announces an open competitive examination for assistant chemical engineer, applications for which must be on file not later than July 5. The examination is to fill vacancies in the federal classified service, for duty in Washington, D. C., or in the field, at an entrance salary of \$2,400 a year.

ANNOUNCEMENT is made by Dean Franklin Moon, of the New York State College of Forestry, Syracuse University, that twenty-eight members of this year's senior class received instruction at the Pack demonstration forest from April 28 to June 2, situated near Lake George in the heart of the finest pine region of the state. This forest was given to the college about two years ago by the Charles Lathrop Pack Forestry Trust for the purpose of serving as a demonstration forest and research area combined. Being located on the main highway from Albany to Montreal the roadside demonstrations in field reforestation and underplanting, thinnings to accelerate growth, pruning of young pines to improve the quality of the timber, can be observed by the thousands of tourists who pass this forest each year. In addition to the regular staff of instructors, foresters from Denmark and Switzerland conducted research and assisted in instruction during the period.

DR. GEORGE GRANT MACCURDY announces the completion of plans for the eighth summer session of the American School of Prehistoric Research, of which he is director. The term will open in London on July 2 and will close on the continent the middle of September. Among the special invitations received by the director is one from Professors Depéret and Mayet, of the University of Lyon, which will give the students of the school an opportunity to take part in the excavations at the celebrated station of Solutr . Beginning in October, representatives of the school will cooperate with representatives from Oxford Uni-

versity on a joint exploring expedition in Irak. Dr. and Mrs. MacCurdy will sail for London on June 15 on the *Tuscania*.

EARLY human remains will be sought in Southwest Africa by the Cameron-Cadle Kalahari Desert expedition, which sailed from New York on June 1. Ethnological, geological, medical and photographic experts make up the expedition, which has booked passage from Southampton to Cape Town on the steamer *Kenilworth Castle*, sailing on June 15. The expedition's financial backer is Will J. Cameron, of Cameron's Surgical Specialty Company, of Chicago. Mr. Cameron will undertake to find a specimen of the web-footed lizard to bring back for the Field Museum of Chicago, also other specimens which that museum wishes to add to its collections. Dr. C. Ernest Cadle will represent the Colorado Museum of Natural History. Another member of the expedition is Professor R. L. Mannen, of San Antonio, who will represent the University of Texas and the Willie Museum of San Antonio. Fred Parrish and Hank Hoder, of Colorado Springs, will make motion and still pictures for the expedition.

THE Russian Academy of Sciences, jointly with German scientific institutions, is organizing a scientific expedition to the Pamir for the exploration of the Altai mountain range. Part will be taken in the expedition by Professor Stcherbakov, Professor Belayev, Professor Korzhinevsky, of Tashkent University; Professor Sicker, of the Geological Institute of Berlin; the German geologist Ritmer, and others.

A SUM of \$25,000 has been placed at the disposal of the Royal Society of Canada as a nucleus for an endowment fund by the Carnegie Corporation of New York, according to an announcement by Sir Robert Falconer, president of Toronto University.

## UNIVERSITY AND EDUCATIONAL NOTES

GIFTS to Columbia University amounting to \$241,159 have been announced by President Butler. F. W. Vanderbilt was the largest contributor, giving \$116,666.66 toward a pledge of \$350,000 to enable the university to install the Vanderbilt Clinic in the new medical center. Harold S. Vanderbilt, who has pledged \$150,000, gave \$50,000 to the clinic.

DR. ALLEN W. ROWE, director of research at the Evans Memorial Hospital, Boston, has been elected president of the Boston School of Physical Education.

DR. GERALD WENDT, who was recently appointed director of the new Battelle Memorial Institute for scientific and industrial research at Columbus, Ohio,



has resigned from that position after completing the plans for the laboratory and the award of the contracts and has been appointed assistant to the president of the Pennsylvania State College, where he has for four years been dean of the school of chemistry and physics. He will continue as acting dean for a year but will devote himself primarily to research administration and the development of the large research program of the college.

DR. JACQUES BRONFENBRENNER, of The Rockefeller Institute for Medical Research, has been appointed professor and head of the department of bacteriology and immunology at Washington University Medical School, St. Louis.

DR. OSCAR V. BATSON, professor of anatomy at the University of Cincinnati College of Medicine, has been called to the chair of anatomy in the graduate medical school of the University of Pennsylvania, where he will take up his duties in the fall.

IN the department of anatomy in Columbia University, Dr. Dudley J. Morton, assistant professor of surgery at Yale University, has been appointed associate professor, and Dr. W. M. Copenhaver, instructor in anatomy at the University of Rochester, assistant professor.

PROFESSOR L. W. CURRIER, associate professor of mineralogy at the Missouri School of Mines, has been appointed associate professor of engineering geology at Purdue University.

DR. J. E. WELSTER, Ph.D. (Ohio State, '28), formerly of the Boyce Thompson Institute, Yonkers, has been appointed assistant professor of agricultural chemistry at the Oklahoma Agricultural and Mechanical College.

DR. DEA B. CALVIN, now holder of a Porter fellowship of the American Physiological Society at Yale University, has been appointed instructor in physiological chemistry at the University of Missouri.

DR. HUBERT ERHARD, professor of zoology at the University of Giessen, has accepted the chair of zoology at Freiburg.

## DISCUSSION AND CORRESPONDENCE

### THE APPORTIONMENT OF REPRESENTATIVES

PROFESSOR HUNTINGTON's criticism in *SCIENCE* for May 18 (p. 509) of my action regarding apportionment invites me to discuss in your columns a question of much public importance.

A census of the United States was taken in 1920, but no apportionment law redistributing members of

the House among the several states has since been passed and it seems practically certain that none will be passed until the next census is taken. This is the first time in 130 years that Congress has neglected its duty to apportion representatives. The primary reason for the failure is the sharp difference of opinion between two groups of representatives nearly equal in size, one wishing to apportion but unwilling to increase the present size of the House, the other unwilling to apportion unless that size should be increased by the same act, perhaps to the point at which no state would receive less than its present number of members. The second group has been successful in each apportionment since 1880 and the size of the House increased thereby from 332 to 435 members. Owing to this clash of opinion Congress has been deadlocked for seven years. After the next census shall have measured the population changes between 1910 and 1930 it will probably appear that if the House is not increased in size about seventeen states would each lose one or more representatives and that if each state is to retain or increase its present membership it would be necessary to increase the House by about 100 members, nearly one fourth of the present number. Under those conditions the difficulty in securing the passage of an apportionment law will be greater and the precedent for inaction set in the decade now ending seems likely to be followed.

To diminish this danger I revived a suggestion which I had made in 1915 that Congress should revert to the precedent set in 1850 and make the decennial apportionment a ministerial act. For that purpose it would need to pass a law authorizing the President or the Secretary of Commerce, in whose department the bureau of the census lies, to apportion the present number of representatives, 435 (or any other number that might be preferred) by the method last used by Congress (or any other method that might be preferred) as soon as the figures of each successive census were announced and report the results to Congress. This would not, of course, tie the hands of any future Congress but it would secure an automatic readjustment of the number of members last approved to the changes of population in each decade in case Congress by its inaction failed to express any other preference in the matter. The committee welcomed the suggestion and amended the original draft to give Congress one session after the census figures were reported in which to agree upon a bill. If it did not so agree the apportionment was to be made by the executive acting under these instructions.

This proposal raised the question: What method should be prescribed in such a bill? My own view

was and is that the method as well as the number of representatives last approved by Congress should be prescribed and that view was adopted by the committee.

It is this decision which is distasteful to Professor Huntington. After the census of 1910 improved methods of dealing with the apportionment problem were laid before the committee on the census by Dr. J. A. Hill and by me. The committee approved my proposal and based the apportionment law of 1911 upon it. In 1921 Professor Huntington improved upon Dr. Hill's method and urged this method of equal proportions, as it was then called, upon Congress. It was considered and approved by the advisory committee to the director of the census but neither Congress nor a committee of Congress has endorsed it. In 1927 and 1928, when the committee on the census held hearings on the bill for ministerial apportionment, each method was advocated and the committee decided to follow congressional precedents in the matter. In my opinion the prescription of a novel method would have increased the obstacles to the bill, obstacles which I regret to say have proved insurmountable, the bill having been defeated in the House May 18th by a vote of 164 in favor and 186 opposed.

Perhaps the main difference between Professor Huntington and me is over the nature of the problem. He treats it as a statistical or "purely mathematical" question which mathematicians and statisticians are to solve, while Congress should accept their solution. I regard it as a political problem in which the scholar should attempt first to find what end the constitution or Congress aims at and then devise or improve a method by which Congress may accomplish that end. The function of mathematicians in the problem is not to choose among ends but merely to determine how some primary end of apportionment can best be secured.

Upon this main difference another depends. Professor Huntington thinks I owe it to the world of scholars to defend my heterodox opinions by publishing them "in some regular journal." My main purpose, however, has been to help Congress out of a dilemma and I am not interested in justifying my course in so doing to my academic colleagues. If any reader wishes to obtain the material for an independent judgment about my position and arguments and the validity of Professor Huntington's criticisms of both he can best do so by asking the Chairman of the House Committee on the Census, Honorable E. Hart Fenn, for a copy of the Committee Hearings of February, 1927, and February, 1928.

One of the main objections to the method of equal proportions is that to the non-mathematician in Con-

gress or out it is almost unintelligible. The comments upon that method made by two scholars who at my request read the hearings before the census committee, including testimony and memoranda by Dr. J. A. Hill, Professor A. A. Young and Professor E. V. Huntington, may be cited in support of this claim. The late James Parker Hall, dean of the University of Chicago Law School, wrote about the method of major fractions: "It is much easier to explain (to any one but a society of mathematicians)." A distinguished teacher of political science in one of our leading universities wrote: "I read very carefully Professor Huntington's explanation of the method of equal proportions contained in the hearings. I confess my inability to comprehend it." In the congressional debate on the bill just defeated the leader of the opposition to it and the senior Democratic member on the Census Committee said: "I presume the mathematicians know what they are talking about. Nobody on the committee knew whether they were right or not."

WALTER F. WILLCOX

CORNELL UNIVERSITY

#### TRANSPLANTATION OF THE EUROPEAN OYSTER

It is well known that the accidental introduction of the Portuguese oyster (*O. angulata*) into Arcachon Bay in France has led to the establishment there of a great breeding-ground and immense production of this oyster on beds which were formerly occupied only by the European oyster (*O. edulis*).<sup>1</sup> Portuguese oysters, which do not occur naturally on English oyster-beds, are also grown and well fattened on these beds on a commercial scale after transplantation of the young from Portugal or France. There is, therefore, evidence that this kind of oyster will live and thrive in situations other than those in which it occurs naturally, and there is every reason to believe that other kinds of oysters can be transplanted—with circumspection—to obtain similar results. The European oyster is generally regarded as a superior article of food to the American oyster, and for that reason should be of greater commercial value. There are indeed physiological reasons for believing that *O. edulis* fattened on the West Atlantic Coast would compare favorably with the best American shell-fish. The object of this note is to suggest that the European oyster especially may be expected to breed and flourish in the beds in the northern states and in Canada on the Atlantic coast and that the transplantation of this species should not be a difficult matter.

<sup>1</sup> M. Dantan, *Comptes Rendus Acad. des Sci.*, Feb. 2, 1914, Paris.



In reviewing the characters of the dominant species of oysters throughout the world it has been shown that two distinct types may be recognized. Type I consists at present of *O. virginica-elongata*, the American and Canadian oyster; *O. angulata*, the Portuguese oyster; *O. cucullata*, an oyster of world-wide distribution in tropical and subtropical regions.

Type II consists at present of *O. edulis*, the European oyster; *O. lurida*, the British Columbian oyster; *O. angasi*, the south Australian mud-oyster.

The oysters of Type I flourish in tropical or subtropical regions; have small eggs, which are thrown directly into the water, and are either male or female.

The oysters of Type II, on the other hand, flourish in temperate regions; have large eggs, which are incubated inside the shell until developed into a free-swimming larva, and the individuals are hermaphrodite.

Now the oysters of Type II occur, in the northern hemisphere, on the west coast of Europe and the west coast of North America, but not on the Atlantic coast of North America. In the southern hemisphere this type occurs in the south of Australia and the south of New Zealand. Why, then, is a dominant member of this type absent from the Atlantic coast of America?<sup>2</sup> It seems highly improbable that there can be any other answer to this question than could be supplied by geological changes, if sufficient knowledge were available. There is every reason to believe that the biological conditions in the estuaries in the middle part of the Atlantic coast of North America would be eminently favorable to the European oyster. The reverse of this has been proved<sup>3</sup> in the case of the American slipper-limpet, which was introduced on American oysters into the Thames estuary in England and has flourished there exceedingly well. It is equally probable that both the European and British Columbian oysters would also thrive on the Atlantic coast, and quite probably increase at a great rate on the warmer beds.

In these days of rapid transport it should be possible to relay oysters from Europe or British Columbia to the American or Canadian Atlantic beds within a few days and with no greater mortality than occurs on relaying from one European bed to another. Any scheme of transplanting, however, ought to be well thought out and should aim at relaying a maximum number of individuals in a small area in secluded estuaries where there is a minimum tidal current.

J. H. ORTON

MARINE BIOLOGICAL LABORATORY,  
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<sup>2</sup> J. S. Gutsell in *SCIENCE*, LXIV, No. 1662, 1926, describes a small species of this type from Beaufort, N. C.

<sup>3</sup> J. H. Orton, *Proc. Roy. Soc., B*, Vol. 81, 1909.

## THE BOILING-POINT AND THE LATENT HEAT OF VAPORIZATION OF WATER

THE teaching of loose concepts in physics in the high schools and colleges may lead to the acquisition of incorrect habits of thinking. Many text-books of physics leave the student with the impression that the boiling-point and latent heat of vaporization of water are immutable constants. The concept of the boiling-point of water being 100° C. is drilled so deeply in the mind of the student that it becomes exceedingly difficult later to uproot this idea. Invariably, when the boiling-point of water is mentioned, the student thinks of 100° C. or 212° F. and a latent heat of 540 calories per gram; that water exists as such only below 100° C., and only as steam above this temperature. Neither is it sufficiently impressed on the student that the latent heat of vaporization is not a constant, but a variable which is a function of the vaporization temperature.

Illustrative of the looseness found in the statement of calorimetric problems is the following one taken from a standard text-book. "How much steam at 150° C. must be added to 1 kg of ice at -10° C. to give nothing but water at 0° C.?" Since no pressure is stated, presumably the student is to assume a boiling-point of 100° C.

Another well-known text-book makes the following statement in explaining the determination of the latent heat of vaporization of water: "In condensing, its latent heat of vaporization is given up and the condensed water is cooled from 100° to the final temperature of the calorimeter." Apparently the figures 100 represent a sacred number.

In a third text-book it is stated that "brine must be raised above 100° C. to boil." As if pure water can not be made to boil above 100° C. or that it must boil at 100° C.! What must the student think of his physics text-book when he observes water above 100° C. being fed to the boiler of a power-plant?

In a fourth text the author after carefully showing that the boiling-point and latent heat of vaporization are variables rather than constants, then proceeds to give an illustrative problem of an experimental determination of the latent heat of vaporization, and without stating any pressure, tacitly assumes that the boiling-point is 212° F.

In a fifth text the following usual problem is given: "How much heat would be required to change 10 grams of ice at -10° C. to steam at 110°? Assume a specific heat of steam at constant pressure equal to 0.5." To solve this problem the student takes for granted that the boiling-point is 100° C., and that the steam has been heated from 100 to 110. Soon he arrives at such a habit of thinking that no problem in saturated or superheated steam can be solved unless that mystic number 100 is introduced into the prob-

lem. It would be very desirable if authors of general physics text-books could be induced to exercise greater care in the treatment and statement of problems in calorimetry.

J. B. NATHANSON

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### CORYNEUM CANKER OF CYPRESS

THE Monterey cypress (*Cupressus macrocarpa*) is widely planted in the warmer temperate parts of Europe, South America, Australia and New Zealand. It has long been a favorite for hedges, windbreaks and for park purposes in the coastal region of its native California, occurring so generally that, like eucalyptus, it has become a characteristic of the landscape. The early California plantings enjoyed comparative freedom from pests and diseases. Then insects gained a foothold, becoming particularly active in trees on unfavorable sites and in the warm, dry interior valleys. Nearer the coast the cypress fared better and, while a gradual increase in damage from insects and root troubles has been noted, the loss among trees under proper care has not been large until the last two or three years, when dying back of specimens of all ages became general around the south half of San Francisco Bay. The injury was first attributed to the attack of bark-beetles, as these insects were commonly present in the dead trees. Mr. J. M. Miller, entomologist, United States Department of Agriculture, in the spring of 1927, reported to this office that he was unable to trace the dying back in certain trees at Palo Alto and Stanford University, California, to insects. From the appearance of the affected parts he was led to believe that a fungous disease might be responsible. The same trouble has since been found to be general in the portions of Alameda, Santa Clara and San Mateo Counties adjacent to San Francisco Bay. It has also been reported from Sacramento County, but is not yet definitely known to occur elsewhere.

Affected trees become conspicuous through the dying of individual parts of the crown, either branches or portions of the top. This continues until finally the entire tree is either killed or is rendered so unsightly that its removal becomes necessary. An inspection shows the dying to be due to the girdling action of bark cankers caused by a fungus. The affected bark first swells and soon begins to die in the central portion of the canker. The dying is accompanied by heavy resin flow, which furnishes one of the most characteristic indications for the presence of the canker. Ordinarily branch cankers are less than a foot in length, but on the main stem they may be longer. A pitch moth commonly works among the resinous material on the diseased bark, giving the

appearance at first glance of being connected with the injury. The causal fungus is an apparently undescribed species of *Coryneum*, the blackish pustules of which usually appear irregularly scattered over the surface of the discolored, dead bark of the cankers. Inoculations on young Monterey cypress with spores of the fungus resulted in positive infections, both on wounded and unwounded young bark and on unwounded foliage. Typical acervuli of the *Coryneum* developed from a number of the infections. The common avenues of infection in the open have not yet been definitely determined. As control measures the removal of sources of further infection by the cutting-out and destruction of all cankers followed by applications of a standard fungicidal spray are indicated. So far the disease is confined mainly to Monterey cypress, but the well-known Italian cypress (*C. sempervirens*) is also severely attacked and it is not unlikely that other cypress species may be found susceptible.

No clue as to the origin of the disease has been found. To all appearances it has been present in certain of the localities where it is now serious for perhaps four or five years, but beyond that nothing is known. There is no record of any disease resembling it on the native cypresses of the state. Irrespective of its origin the canker has sufficiently demonstrated its destructive possibilities to warrant efforts for the prevention of its spread to localities where it is not now present. Further studies of the disease are under way.

WILLIS W. WAGENER

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### MORE RESEARCH

SPEAKING of *research*: Ré-search is bad enough, but how about ré-zearch? One hears this occasionally from doctors of philosophy in various sciences. I once knew a minister who used frequently to pray for ré-zawrse, thus perpetrating three distinct errors in one comparatively short word.

JAMES S. STEVENS

ORONO, MAINE

IN reference to the letters as to "The Pronunciation of Research," in *SCIENCE* for May 4, I think there will be universal agreement that the Oxford Dictionary is the final court of appeal as to spelling and pronunciation of English. That gives the accent on the second syllable of "research" used both as a noun and a verb, and also places the accent on the second syllable in "researcher."

W. H. KUN



If there were any valid argument for accenting "re-search" on the first syllable, it would equally well apply to a great number of other words beginning with "re-," in which the force of the prefix is exactly the same (for those who advocate accenting the penult, "reinter" is a good one for practice!).

The solution of this problem (and of all others of similar character) is clearly and definitely indicated in an admirable little book by Martin C. Flaherty, entitled "How to Use the Dictionary" (Ronald Press Co. 1923). It can be read in a few hours and will richly repay the effort.

E. H. McCLELLAND

CARNEGIE LIBRARY OF PITTSBURGH

### CORRECTIONS TO THE BIOGRAPHICAL DIRECTORY OF AMERICAN MEN OF SCIENCE

In the fourth edition stars should be attached to the subjects of research of Dr. Atherton Seidell, chemist in the hygienic laboratory of the U. S. Public Health Service, and of Dr. T. Wingate Todd, professor of anatomy in Western Reserve University. The copy was correct, but unfortunately the errors were passed by the proofreaders.

In the table (page 1128) showing the strength of institutions in the different sciences, Harvard University should be given a rating of 4.6 in anthropology, one man who was called to Harvard before the date of reference not having been so recorded. This places Harvard first among universities in anthropology and further emphasizes its dominant position. Changes in position are frequent, the situation having altered in a number of institutions between the date to which the table refers and the time of its publication.

Several less serious errors have been discovered, as also the omission of names that should be included. The latter situation, however, is inevitable, partly owing to the large number of individuals concerned and partly because some scientific men will not reply to requests for information.

J. McKEEN CATTELL

### REPORTS

#### WORK ACCOMPLISHED BY THE FIELD MUSEUM PALEONTOLOGICAL EXPE- DITIONS TO SOUTH AMERICA

THE work undertaken by the Field Museum paleontological expeditions to Argentina and Bolivia has been finished. The party composing the second expedition returned to Chicago in November, 1927. Collections brought together by these expeditions from many localities have now been received at the museum.

These expeditions, made possible by the generous support of Captain Marshall Field, were active from 1922 to 1927. The work has been carried on by two successive expeditions under the leadership of the present writer. The object was to make collections of fossil mammals from as many as possible of the known fossil-bearing horizons of South America. A similar undertaking had not been made by a North American institution since the Princeton University expeditions to Patagonia of 1896-99.

The first expedition, consisting of E. S. Riggs, G. F. Sternberg and J. B. Abbott, set out from Chicago early in November, 1922, and proceeded to the Santa Cruzian formations of southernmost Argentina. Near the Port of Rio Gallegos the first working base was established. Collecting was carried on in the province of Santa Cruz until the end of the following May, when the approach of southern winter made a movement northward advisable. Collections amounting to 282 specimens of fossil mammals, together with a few specimens of fossil birds, were made from the Santa Cruzian formation. This number included 177 skulls, with a few skeletons more or less entire. According to field determinations, this collection included thirty-two genera of fossil mammals, and a considerably larger number of species.

With the approach of winter the party moved northward to the vicinity of Comodoro Rivadavia. There the months of July and August were passed in collecting recent mammals and birds when weather conditions permitted.

The second working season, from September to May, 1923-4, was devoted to collecting fossil mammals from the earlier fresh-water formations, designated by North American geologists as the Deseado Series, and referred by them to the Oligocene period. Collections of fossil shells to the number of three hundred, and a few specimens of cetaceans, were also made from the Patagonian Beds. Some collections of Cretaceous dinosaurs were made from the San Jorg formation. A fossil forest of *Araucaria* was discovered near Cerro Madra y Higa of the province of Santa Cruz, and a collection of 250 specimens of cones, twigs and branches made from it. Unrecorded occurrences of Deseado mammals were examined near this point and at another locality in the vicinity of Pico Truncado.

Of the Eocene mammals, only a limited collection was made from the "Nothostylops Beds" of Ameghino. A larger collection, comprising 256 specimens, was collected from the upper fossil-bearing horizons of the Deseado formation, including the "Astraponotus Beds" and the "Pyrotherium Beds" of Ameghino. No less than eight widely separated fossil-bearing localities were examined, and a reconnaissance was made through the northern part of the province of

Santa Cruz and the southern part of the province of Chubut.

In May of 1924 the party again moved northward to escape the severe weather of winter. The two collectors then returned to the museum. The leader with one assistant visited the Pliocene (Araucanian) exposures along the River Parana without discovering any promising collecting grounds. A collection of 110 Pliocene invertebrates was there made. The party then proceeded northward to Bolivia. The succeeding winter was devoted to collecting in the Pleistocene formation about Tarija. Local men were employed as collectors and work was carried on there from July to December. This resulted in a collection of 126 specimens of Pleistocene mammals of both indigenous and immigrant stocks. Among this number are three large skeletons and a number of skulls.

Returning to Buenos Aires in December the party disbanded. Plans were then laid for the work of a second expedition. Reconnaissance was made by the leader through the Pampean formations and westward along the Rio Negro as far as Neoquen. The dinosaur-bearing localities of the Roca formation were there examined. The leader of the expedition then returned to the museum to recuperate and to organize a second expedition.

The personnel of the second expedition included, under the same leader, Mr. R. C. Thorne, of Chicago, and Dr. Rudolf Stahlecker, of the University of Tübingen, as collectors. Camp men and other helpers were employed as occasion arose. The party set out from Chicago in April, 1926, proceeding to Buenos Aires and thence to the northern provinces of Argentina.

The first task of this expedition was to find a productive locality and to make collections of Pliocene mammals. The Araucanian formations of the River Parana and of the southern coast of the Province of Buenos Aires had long been exploited by Argentine collectors and did not at this time offer promise of good collections. Attention was therefore directed toward the Catamarcan formation of the northern provinces. The known locality of the Valley of Santa Maria in the Province of Catamarca was first visited. Local help was employed, pack-animals and mounts were secured, camp established and collecting begun about the twentieth of May.

The massive sandstone and indurated clays exposed in abrupt cliffs at the base of the Aconquija Mountains yielded important returns. This locality was small and soon exhausted. The Santa Maria valley was then explored northward into the provinces of Tucuman and Salta. Finding less promising fields in that direction, the base camp was moved to Puerta Corral Quemada in the Department of Belen. A new field was there developed which proved most produc-

tive. The Catamarcan formation, composed of sandstones and clays similar to that of the Valley of Santa Maria, was found to reach a thickness of more than six thousand feet. This series was exposed in mountain ridges, with included valleys, everywhere highly inclined and folded, and evidently of pre-Andean age. The fauna contained in this formation proved to be essentially the same as that of the type locality near Santa Maria. The lowermost measures of reddish sandstones yielded a scant fauna of toxodonts and glyptodonts. The middle measures yielded a typical Araucanian fauna similar to that of Entre Rios, the type-locality in the Valley of Santa Maria. The upper measures revealed a more varied, and somewhat later, fauna, which appeared to be forerunners of well-known Pleistocene animals.

Collecting was carried on along the River Corral Quemada until the beginning of the rainy season in November. The entire collections were then gathered at Andalgalá for shipment by railway and the party moved southward for the ensuing summer. The collections made from the Catamarcan formation included glyptodonts of five or more genera, gravi-grade sloths of two genera, armadillos in considerable variety, two or more forms of toxodonts, four forms of typotheres, one of macrauchenids, a procyonid, one or two marsupials and a profusion of rodents of indigenous forms. There were also found some variety of large birds, a single species of great tortoise and a few small batrachians. The collection from the Catamarcan formation numbers 181 specimens of fossil vertebrates. Invertebrates were found in the lower horizon only. The entire fauna is so different from that of the Santa Cruzean beds as to indicate a prolonged interval of time between the close of the Santa Cruzean period and the beginning of the Catamarcan.

The expedition had by this time secured representative collections from the Deseado series, the Santa Cruz formation, and from the Catamarcan formation, which, following North American geologists, may be designated as of Oligocene, Early Miocene and Pliocene age, with a moderate representation of early Pliocene mammals from the Tarijan formation. Attention was now fixed upon the great indigenous mammals of the South American Pleistocene. From the discoveries made by South American paleontologists during the past seventy-five years, this fauna appears to have found its best expression in the Pampean formations of central Argentina. In this populous region the Pampean fossils had been correspondingly exploited by local and visiting collectors. The task of making collections from this formation was therefore entered upon with some doubt as to success. On the other hand, specimens of the great ground sloths and of glyptodonts were especially desired because of



their immense size and their unique characteristics, which render them of especial value as museum exhibits.

Localities along the southern coast of the Province of Buenos Aires were selected as offering the best prospect of securing good specimens of the great Pampean mammals. The motor equipment, which had been stored since the first expedition, was again brought into use. The coastwise exposures from Bahia Blanca to Miramar were gone over. Some collecting was done on the beaches as exposed at low tide, along the low sea-cliffs and among sand dunes near the shore, where small areas had been denuded by wind erosion. More favorable collecting grounds were found along the banks of certain rivers, whose channels have, in their lower courses, cut through the entire Pampean formation. These steep banks, swept clear of debris by floods in every period of high waters, offered the most favorable opportunity for discovering specimens.

From these localities a collection of sixty-two specimens was secured. Among the number is more than half of an articulated skeleton, including head, of the greatest of the ground sloths, *Megatherium americanum*. Excellent articulated skeletons of the intermediate-sized sloths, *Scelidotherium* and *Glossotherium*, good specimens of the great saber-tooth tiger and of the Argentine mastodon, and various specimens of fossil horses, llamas and rodents were also secured.

This work held the expedition in the south until the close of the southern summer. In May the party again moved northward to continue collecting in the Pleistocene valley-deposits of Bolivia. Dr. Staehlecker, who found it necessary to return to Germany at this time, was replaced by Sr. Jose Strucco. A new force of camp men and helpers also was employed.

As soon as preliminaries had been arranged, the party pushed on from Tarija into the small, isolated valley of Patcaya. There a formation of valley sediments similar to that of Tarija was found. Quarters were established for the winter and collecting was begun among the arroyos and thornbushes of this mountain district. The prize specimen here secured was an articulated skeleton, almost entire, of the mountain species of the great sloth, *Megatherium tarijensis*. Specimens of the equally large sloth, *Lestodon*, rewarded prolonged excavations in an old stream-channel. Two articulated skeletons of *Glossotherium* compensated for months of patient search through bush-lands. Various specimens of the Andean horse and of camels and llamas added to the sum total of the winter's collection.

By the end of September, 1927, collecting by the second expedition was terminated. Shipments were made during the succeeding month. The party then

returned to Chicago by way of Peru and the western coast.

The results of the two expeditions may be summed up as follows: Representative collections of fossil mammals were made from the Eocene, Oligocene, Early Miocene, Pliocene and the Earlier and Later Pleistocene of Argentina and Bolivia. During this work the Field Museum parties examined most of the formations of Argentina and Bolivia which have yielded fossil mammals. Collections were made from no less than twenty-two different localities, several of which were first made known by the labors of these expeditions. Fossil invertebrates were collected from Cambrian, from Miocene and from Pliocene formations. A rare collection of fossil cones, twigs and branches of the genus *Araucaria* was made from fossil trees found *in situ* near Cerro Madre y Higa, of the province of Santa Cruz. Small collections of recent mammals, birds and reptiles were made; also collections of flowering plants from the provinces of Chubut and Catamarca. Studies of stratigraphy in the several fossil-bearing localities were carried on and a number of geological sections were prepared. A series of some twelve hundred photographs were made for the purpose of recording the work of the expedition, as well as to illustrate subjects of more general interest.

Through the courtesy of the Argentine and the Bolivian governments, all these collections, excepting a certain number of duplicated specimens, were permitted to be exported to the United States. The various shipments, totaling nearly three thousand specimens of fossil mammals, birds, reptiles, mollusks and plants, have safely arrived at the Field Museum. The preparation and the study of these collections will require a period of years. A number of specialists in various lines have been invited to assist in this task.

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## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### MAKING A CORRECT MECHANICAL ANALYSIS OF SOILS IN FIFTEEN MINUTES

IN previous communications the use of the hydrometer method has been proposed as a rapid and simple method for the study of soils.<sup>1</sup> A very comprehensive study has been made to ascertain if the method could be used for making a mechanical analysis of soils. It has been discovered that if the soil particles are grouped into three main groups—sand, silt and clay or colloids—these three groups can be determined by

<sup>1</sup> *Soil Science*, No. 5, 1927; No. 4, 1927; *SCIENCE*, July, 1927.

the hydrometer method rather remarkably correct in only fifteen minutes by making only two readings, one at the end of one minute and the other at the end of fifteen minutes. In making these studies about thirty different soils were obtained from the United States Bureau of Soils whose complete mechanical analysis was known. It was found that the percentage of material that settles out at the end of one minute in the regular hydrometer method is almost exactly the same as the percentage of all the combined sands obtained by the mechanical analysis method. If the percentage of material that settles out at the end of fifteen minutes minus the sand which settles out at the end of one minute is considered to be silt, and if the material that still stays in suspension at the end of fifteen minutes is considered to be clay or colloids, it was found that the mechanical analysis and hydrometer methods agreed quite closely in the soils whose silt content was composed mostly of the coarser size—in the neighborhood of .05 mm and disagreed rather widely in the soils whose silt content was composed of the finest size—in the neighborhood of .005 mm. This is as should be expected because recent studies go to show that the finer silt has practically the same characteristics as the clay and should be classed, therefore, with the clay, while the coarser silt does not possess the same characteristics. The hydrometer method, therefore, includes in its clay or colloidal determination the finer silt but not the coarser silt, consequently the hydrometer method would agree with the mechanical-analysis method in soils with the coarse silt content but not with the finer silt content. In other words, the hydrometer and mechanical-analysis methods agree almost perfectly in the determination of the combined sands, coarser silt and clay. Where they do disagree is in the finer silt. The mechanical analysis classes this fine silt with the coarse silt, where the hydrometer method classes this fine silt with the clay, because it has more of the characteristics of clay. Hence there is no serious and radical disagreement between the two methods.

If it is desired to determine only the total sand and the total silt and clay, these determinations can be made by the hydrometer method in only one minute and will be very correct.

With the aid of Stokes's law, the hydrometer method can also be used to make a very detailed mechanical analysis of soils.

Although the method may appear too ideal to be true, yet all facts point such to be the case. Indeed, the method appears to be a rather remarkable and unique means of studying soils quickly, simply and accurately. For all general and practical purposes this method gives nearly all the information that is

necessary and essential regarding the physical composition of soils. And in many cases such information seems to be more true than that of the mechanical-analysis method.

Finally, it must be stated that the criticisms which Joseph and Keen have made in *Soil Science* regarding the hydrometer method are not justified and do not apply to the method as is shown elsewhere.

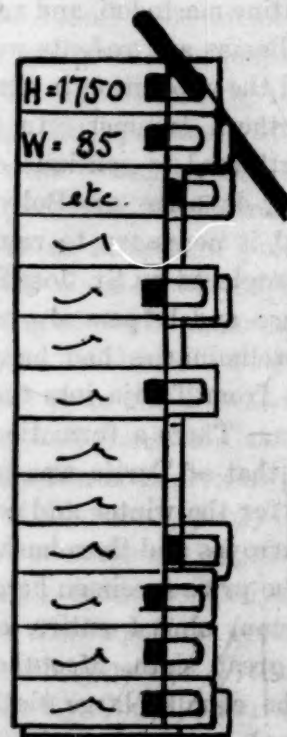
GEORGE JOHN BOUYOUCOS

MICHIGAN AGRICULTURAL EXPERIMENT STATION

### A SIMPLE METHOD OF PICKING UP CORRELATIONS<sup>1</sup>

In dealing with a long series of systematic observations on individuals, as in the routine work of the Constitution Clinic in the Presbyterian Hospital—besides the opportunity of working out the type characteristics of any group under investigation—there is the possibility of finding a large number of correlations. If there are  $n$  observations on each subject or patient, there are  $n(n-1)/2$  correlations of the first order. A fair estimate of the significant correlations can be obtained by means of the home-made sorting machine to be described.

The observations on one individual are recorded on a long card about 5 cm. high in vertically ruled spaces



1 cm. wide. Each observation is then compared with some given criterion and classified as plus or minus, yes or no. If the observation is plus, a clip is attached in the appropriate position along the top of the

<sup>1</sup> From the department of medicine of the College of Physicians and Surgeons of Columbia University and the Presbyterian Hospital, New York.



card. When all the cards are filed together, the spaces in which a certain observation has been recorded lie one behind the other; and the clips protrude above the level of the file in their respective rows. Each clip has a hole in it so that a rod may be passed through all the clips in any particular row.

Supposing that there are forty-eight cards in the group, and that for each character the median value has been selected as the criterion. If then it is desired to find the association between one character (*e.g.*, height) and any other character (*e.g.*, weight), the cards for the twenty-four tallest individuals are raised by passing a rod through the clips in the height row. If there were no association between height and weight, there would be, on the average, twelve out of the twenty-four heavy individuals among the twenty-four tall ones—less than twelve if the association is negative, more than twelve if the association is positive. The actual number can easily be determined by counting the clips (or the empty spaces) in the weight row which appear among the cards which have been lifted. In fact, the single operation of raising the cards belonging to the tall subjects reveals at a glance any significant association between height and any other character observed. A second rod enables one to examine "second-order" associations, *i.e.*, to raise the cards belonging to the individuals who are both tall and heavy.

For the mathematical treatment of data obtainable by the above procedures, for calculating correlation coefficients, and for some of the pitfalls of interpretation, reference may be made to Yule's book<sup>2</sup> especially chapters V and XI.

Arrangements are being made for the manufacture of the sorting-clips. It is thought that these clips will also be useful in the analysis of questionnaires and in the investigation of sociological problems.

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## SPECIAL ARTICLES

### A BIOELECTRIC POTENTIAL

By means of a pair of non-polarizable micro-electrodes that can be inserted into a single living cell,<sup>1</sup> a difference of electrical potential between two points in the protoplasmic stream of the plant cell *Nitella*

<sup>2</sup> G. U. Yule, "An Introduction to the Theory of Statistics," London, 1924.

<sup>1</sup> Gelfan, S., Univ. Cal. Publ. Zool., 29, no. 17, 453, 1927.

was detected and measured. The electrodes are operated by means of a Taylor micro-manipulator, and the electromotive force measured by means of a galvanometer (sensitivity 29,200 megohms), and a potentiometer. The two electrodes are both in the protoplasmic stream, usually about 125  $\mu$  to 150  $\mu$  apart. The difference of the electrical potential ranges from .002 to .004 volts. The E. M. F. drops to zero when the streaming is caused to stop, but will approach the initial magnitude if streaming is resumed. The direction of the current generated with respect to the direction of the protoplasmic streaming is always the same.

Ettisch and Péterfi,<sup>2</sup> using a binant electrometer and micro-electrodes, were unable to detect any potential difference between two points in the interior of the small *Amoeba terricola*. They consequently concluded that no ionic equilibrium that can be measured existed in the protoplasm of this form. In *Nitella* the conditions are somewhat different because of the continual and rapid streaming of the protoplasm. The observed potential difference not only is directly associated with the streaming of the protoplasm, but the two phenomena seem to be dependent upon each other. This is indicated by the fact that the E. M. F. drops to zero when the streaming is caused to stop by a slight mechanical stimulus with one of the electrodes.

In the electrical theories of protoplasmic streaming<sup>3</sup> the view is held that electrical currents are in part concerned in the production of these streaming movements. There is, however, the difficulty in explaining the origin of the E. M. F. The cessation of streaming upon stimulation makes it equally difficult to explain the disappearance of the E. M. F.

The observed potential difference might on the other hand be considered as being produced by the streaming of the protoplasm. We would have, then, in this case, an electrokinetic phenomenon, an E. M. F. that is set up by the impressed motion. This type of an electrokinetic phenomenon is the *streaming potential* and is the reverse of *electrosmosis*.<sup>4</sup> The stationary wall and ectoplasm of *Nitella* are analogous to the solid walls of the capillary tube, and the streaming protoplasm is the moving liquid layer. In *Nitella* the system is a closed one, and the diameter of the cells used ranged from .2 to .4 mm. The conditions for the production of a Helmholtz electric double layer, which is the basis of the explanation of

<sup>2</sup> Ettisch, G., and Péterfi, T., *Plüg. Arch. Phys.*, 208, 3./4. Heft, 1925.

<sup>3</sup> For a discussion of the theories of protoplasmic streaming see Ewart, A. S., "Protoplasmic Streaming in Plants," 1903.

<sup>4</sup> Freundlich, H., "Kapillarchemie," 3rd ed., p. 335.

all capillary electrical phenomena, seem to be present in *Nitella*.

The difficulty encountered in this explanation is the relatively high conductivity of the protoplasm. The E. M. F. of the streaming current is inversely proportional to the conductivity of the liquid. In *Nitella* the conductivity of the protoplasm is equivalent to a .04N KCl solution.<sup>5</sup> According to Krüy,<sup>6</sup> in a  $10^{-3}$ N KCl solution, the stream potential is equal to four millivolts. In higher concentrations no measurable potentials were observed.

The production of the observed E. M. F. would, therefore, only be possible if the  $\xi$ , or electric double layer potential, to which it is directly proportional, were relatively great. This factor, however, is not known for the ecto-endoplasmic surface. A test might be made were it possible to apply the formula for the stream potential, but very little or nothing is known, for protoplasm, of some of the physical constants which are factors in the formula.

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## STUDIES ON THE PHYSIOLOGY OF ASCARIS LUMBRICOIDES

For three years past the writer has been engaged in work on the physiology of *Ascaris lumbricoides*, part of which, because of its practical significance, may well be announced at this time, although the complete report of these investigations will be brought out within the near future. Much of the older work in the form under consideration has been critically repeated, with a resulting revision of accepted views.

Comparative studies on the so-called excretory system have shown that in the forms of the subfamily Anisakinae the supposed excretory system is probably a salivary gland for the secretion of an anticoagulin, and this fact has been reinforced by the demonstration of fragments of the tissues of the host, together with large quantities of blood-corpuscles in the intestine of worms previously not known to have blood-sucking habits. On the other hand, in members of the genus *Ascaris*, evidence has been adduced to show that the so-called excretory system probably serves some as yet unsuggested function. It can not have any important part in the excretory processes, however. In the first place, it would not be expected that the same fundamental structure would in different closely-re-

lated worms have such diverse functions as salivary secretion in one case, and the excretion of waste products in the other. In the second place, conclusive experiments prove that the cuticula, which throughout the literature of helminthology seems to be regarded as a very impermeable membrane, is permeable to excretory products and is the channel through which the end-products of metabolism are carried to the exterior. Thus the nematodes have a cutaneous type of excretion.

Experiments also show that substances may pass in through the cuticula. Sugar in high concentration passes in appreciable quantities through the body wall. Chloroform, in water-solution or suspension, passes into the worm directly through the cuticula and the same is true of carbon tetrachloride. Not only is the rate of ingestion on the part of the worm too slow to account for the rapid toxic effect of these substances, but experimental evidence shows that under unfavorable conditions the movement of the alimentary tract ceases altogether.

Observations with the polarizing microscope demonstrate the sparsity of lipid in the tissues of the worm and show that the aggregates of fatty globules immediately surrounding the nuclei of the muscle cells are true lipin, and not lipid, as was thought by von Kemnitz. The presence of large quantities of fat in the subcuticula and the occurrence of clusters immediately surrounding the nuclei of the worm are sufficient to account for and enhance greatly the effect of anthelmintics, the most effective of which are usually either fatty in character, or fat soluble.

In contradiction of Weinland's conclusions and confirming those of Slater, it is certain that these worms can and do live aerobically. On the assumption of anaerobic life, fat-storage and oxidation can not be regarded as economical processes, and previous workers have regarded fat oxidation as impossible in the worm, and its storage as a mystery. Part of the past misunderstanding on this point has been due to the difficulty of keeping these worms alive under culture conditions long enough to make any careful experiments. I have succeeded in demonstrating by tissue-culture methods that stored fat is burned by the tissues in the usual manner.

Detailed work has been done in connection with the cytological background of the above-mentioned facts, and some further investigations have been made into the tissue chemistry of the worm. The complete evidence for these findings will be discussed at length in my later paper.

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<sup>5</sup> Paper giving these results in press.

<sup>6</sup> Krüy, H. R., *Kolloidzeitschr.*, 22, 81, 1918.



## NEW SCIENTIFIC BOOKS

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## SCIENCE NEWS

*Science Service, Washington, D. C.*

## COMETS AND METEORS AROUND STARS

EVIDENCE that many, if not all, stars are surrounded by meteors and comets like those that we see in the solar system, and that they may serve as fuel to keep the stars going, is the announcement just made by Dr. Harlow Shapley, director of the Harvard College Observatory. If this is correct, it would explain how the stars may survive for a far longer time than the one hundred trillion years that astronomers have recently supposed to be their maximum life.

By means of the spectroscope, which breaks their light up into a rainbow-like spectrum, crossed by numerous dark lines and bands that indicate the constituent elements, Dr. Shapley has studied a large number of stars. Though they are of varying temperatures, and supposed to be of different ages, they all show a band which indicates the presence of cyanogen. This is a gas composed of carbon and nitrogen and which is used terrestrially for killing insects.

Probably, he believes, this cyanogen is not actually in the stars themselves, but rather is it provided by meteors and comets that surround them. Comets and meteors that have come within range of observation have been found to contain carbon and nitrogen as separate elements. When these fall into a star, the high temperature would cause the elements to combine to form cyanogen.

One important aspect of this hypothesis concerns the life of the stars. The generally accepted theory now among astronomers is that the energy of the stars comes from the actual disintegration of their matter into energy. Matter and energy, according to the ideas of modern physics, are both the same, and so one can be changed to the other. In this way, the matter in the average star will keep it running for about 100,000,000,000,000 years. However, if more and more fuel is constantly being shoveled on the stars, in the form of meteoric material, the star might survive almost indefinitely.

## A NEW EXPLOSIVE

RADIUM atomite, the explosive said to be more powerful than T.N.T. or dynamite, is now engaging the attention of army engineers in Washington. The report of Lieutenant-Colonel L. M. Adams, who tested the new explosive at the California Institute of Technology at Pasadena, has just been received, and has been referred to the Board of Engineer Equipment of Troops, at Fort Humphreys.

No details of the composition or samples of the explosive have been received in Washington. Lieutenant-Colonel Adams reported that it is a light greenish powder, dry and very finely divided. The inventor, Captain H. R. Zimmer, of Los Angeles, former army officer, claims that it can be produced for one half the cost of T.N.T. It is declared more stable than T.N.T., and unaffected by dampness, a serious fault of the latter.

In the tests by Lieutenant-Colonel Adams, the power of radium atomite was compared with T.N.T. and 80 per cent. dynamite. A lead cylinder, 12½ inches in diameter, 14½ inches high, with a hole 1½ inches in diameter and 9½ inches deep, was used with each. The entire cylinders each weighed about seven hundred pounds. An ounce of the explosive was placed in the bottom of the hole and covered with three ounces of sand, then the explosive was detonated electrically.

Before explosion, the holes each had capacities of 125 cubic centimeters. T.N.T. enlarged the hole 1,002 cubic centimeters, dynamite 1,255, and radium atomite 1,370.

Tests were also made of the speed of explosion, or how fast the explosive reaction travels through it. This is about 10,721 feet per second for radium atomite, 16,082 for T.N.T. and 8,300 for 60 per cent. dynamite. For general use, it was stated by army engineers, this range makes no practical difference.

Officials of the engineer corps were unable to state whether or not the explosive will be adopted. After the board that is now considering the report is through, they may either request Captain Zimmer to furnish them with samples for additional tests or else invite him to Washington for the purpose.

## STANDARDIZATION OF METERS

STANDARDIZATION of meters for gas, electricity and water was urged by W. T. Henrichson, meter inspector of the state of Texas, in a report to the Conference on Weights and Measures held in Washington. In Texas, meters are supervised both before and after installation. Testing equipment cost only \$1,481.36, but led to savings of thousands of dollars each year for the people in some communities.

Inaccuracy in meters, said Mr. Henrichson, is usually due to incompetent men and neglect on the part of the utility company rather than any deliberate intent to defraud.

Before the passage of the law, a gas company in a Texas city sought to raise rates, Mr. Henrichson related, but the city council decided that the existing rates were adequate to net a fair profit. During one of the meetings, a council member suggested that there should be other ways for the gas company to increase its earnings besides increasing the rates, no doubt having in mind increased efficiency and economy. The gas company acted on his suggestion and increased its earnings. It speeded up every meter in the entire city and increased gross receipts about 25 per cent.

On the other hand, a small gas company was on the verge of bankruptcy. After spending a week testing meters, the speaker found that 25 per cent. of those in service were not registering the gas flowing through them. A much higher percentage of the meters were "slow" and registered only a portion of the gas used. This investigation showed the directors why they were not making money.



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### ANCIENT SKELETONS FROM ALGERIA

WHILE Cro-Magnon man ruled Europe, twenty-five thousand years ago, he had as neighbors in Africa a race who used tools and weapons like his own, but who in their bodily makeup so closely resembled men of to-day that they may fairly be called "modern." This great backward extension of the history of the "modern" type of human beings is the most significant point about the recent discovery by American and French anthropologists of a number of ancient skeletons in a shell mound at Mechta, Algeria. This opinion was expressed by Professor Fay-Cooper Cole, of the University of Chicago, in response to an inquiry by Science Service.

For the past three years Beloit College has been conducting excavations in France and North Africa, under a fund given by Dr. Frank Logan, Chicago philanthropist. Dr. George Collie, director of the museum at Beloit, has spent much time in the field, while active excavation has been carried on by graduate students in anthropology from the University of Chicago.

Last year Alonzo Pond, one of the American workers, found the skeleton of a child in a shell-heap of Cro-Magnon age at Mechta. This year another worker, Paul Nesbitt, took out three more skeletons, while previously a Frenchman named Debrugge had secured a skeleton there.

A careful study of the shell mound and its contents indicate that it seems to be like the Old Stone Age finds of Europe of twenty-five thousand years ago. No New Stone Age objects occur in the site, and no bones of any domestic animals were found—domestication of animals is a "modern" accomplishment. "We seem to be justified in saying that the site is pre-Neolithic, and is probably as old as the Aurignacian," Professor Cole concludes.

The skeletons are neither Neanderthal nor Cro-Magnon. One skull, a woman's, shows negroid characteristics, but the others appear to be rather close to the Mediterranean type, though somewhat more primitive. Fuller details will be announced when the material shall have arrived in America.

### THE PROLONGATION OF LIFE

INSTEAD of using alchemy, or the numerous supposed "elixirs of life" in order to retain youth, the late Dr. A. C. Eycleshymer, of the University of Illinois Medical School, points out in a manuscript left in incomplete form by his death that the quest for youth is not less popular to-day than it has been for countless ages, but the search to-day is becoming more and more scientific, and so is coming nearer to success than any of the older processes. This article was prepared for publication in the *Scientific Monthly* by Dr. Eycleshymer's friend, Dr. E. P. Lyon.

The idea of an elixir of life dates back to Biblical times, when the "tree of life" is introduced in the Garden of Eden. Adam was sent from the Garden, "lest he put forth his hand and take also of the tree of life, and eat, and live forever." This idea that there must be somewhere a tree which was intended to preserve man from disease and death prevailed for ages.

Stars were the next attraction and it was believed that the planets possessed either good or evil qualities which were given to those born under them. Since metals were thought to be intimately associated with the planetary bodies, amulets or figures which had been cast, stamped and submitted to the influence of stars, therefore becoming charmed, became popular. Alchemy succeeded astrology. Liquid gold, when made, would be life. But it was never made. Then came blood transfusion. When in 1667, Denys, of Paris, transferred about a pound of calf's blood into the veins of a maniac, and repeated the process twice, resulting in the death of the patient, transfusion was prevented by law.

To-day, through the avenues of empirical medicine and sanitary science, the expectancy of life has been greatly increased. The average span of life was increased about four years during the seventeenth and eighteenth centuries, about eight years in the first three quarters of the nineteenth century, and about sixteen years since 1875.

"While we have thus made much progress," Dr. Eycleshymer states, "we still lack information in easily accessible fields. While there is always interest shown in plants and animals, the study of man, with a view of preserving and accentuating, in the offspring, the sterling qualities found among the ancestors, has not received serious consideration. Yet we know that heredity is one of the chief factors in longevity."

### POLAR RESCUE EPICS

If the passing hours prove that the *Italia*, with Nobile and his party aboard, is lost in the Arctic somewhere between the North Pole and Spitsbergen, there may be enacted one of the heartrending tragedies of attempted Arctic rescue such as history records. To-day, although the ice is as merciless as ever, circumstances are different from the days when Franklin was lost, when Greely and his brave band starved, or even when the more recent Wrangel Island tragedy was revealed.

In the days when Arctic explorers were limited to difficult sledging over ice, when only a few miles a day could be traveled, the rescue party knew in what general locality to search. If the *Italia's* radio remains silent and gives no clue of the location of that ill-fated ship, Amundsen and his aides in the relief expedition have a difficult task before them. A dozen dirigibles in the best of weather might scour the icy wastes without sighting the landing place of the *Italia*. If the radio brings news of Nobile and his party and gives their location, even then rescue over ice will be difficult enough.

Up until the *Italia's* latest voyage, recent aerial exploration of the Arctic has been singularly without serious mishap. But the first airplane venture pole-



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ward by Amundsen and Ellsworth gave the world some anxious moments while their airplane was down in the Arctic and out of communication. When the *Norge* landed at Teller, Alaska, after its successful trip across the North Pole and the great Arctic blind spot, the news of success was slow in reaching civilization and some at that time thought that dirigible lost.

But the first attempt at Arctic exploration by air, made in 1897, ended disastrously. The Swedish balloonist, S. A. Andree, and two companions, set out for the North Pole in a large free balloon. The start was made from Danes Island, in the north of Spitsbergen, on July 11, 1897. Five tons of supplies were carried. In an hour the balloon was out of sight. That night, seven and a half hours later, a message buoy, found later, was dropped. This was the last trace of the expedition, although years afterwards various unconfirmed rumors of finding the balloon have come out of the Arctic regions of Siberia and Canada.

The Franklin expedition of 1845-48, from which not one of the 129 officers and men returned alive, is probably the most famous of Arctic tragedies. Not until a decade later did searching parties discover the fate of Sir John Franklin and his men and of their accomplishment of the Northwest Passage and other geographic discoveries.

Living in retirement in Washington to-day, there is a survivor of another rescue epic of the north. General A. W. Greely is now eighty-four. In 1881, when a lieutenant, he commanded an expedition the remnants of which three years later were rescued at the point of starvation. Notable scientific explorations were accomplished. Only six returned out of the twenty-five who started, but records, instruments and collections told the story of the efforts of those who perished.

### TREATMENT OF MONGOLOID IDIOTS

MONGOLOID idiots—those baffling cases of defective reclaimed from their smiling, contented state of idiocy and in some cases they may even reach practically normal intelligence. This was the encouraging report made on June 1 by Dr. Walter Timme, of New York, before the American Association for the Study of the Feeble-minded, meeting in Atlantic City.

The cause of Mongolism and how to treat it are still children that look like flat-faced oriental dolls—may be uncertain, though it is generally recognized as a gland disorder. Dr. Timme described his theory, which traces many of the symptoms of Mongolism to faulty development or lack of development of the fore section of the pituitary gland. This gland is located at the base of the brain and its secretions enter both the blood and the cerebro-spinal fluid.

Working on this theory, Dr. Timme stated that he has been feeding Mongoloid patients pituitary substance, both of the whole gland and particularly of the fore lobe of the gland. Hypodermic injections of the gland solution have also been given and in addition the patients have been given the usual thyroid treatment.

"As a result of ten years of this work, I have brought many of my Mongoloid patients to much higher levels than we have heretofore been able to do," he said.

Some of these children, who had started in life with the prospect of remaining idiots, unable to dress themselves, talk properly or even eat like normal children, learned to do arithmetic up to multiplication by three or more figures and long division. They also learned to write letters and do oral arithmetic, which is remarkable achievement for these cases.

One of the patients, described by Dr. Timme, has attained an intelligence quotient of 90, which brings this child up to average intelligence. Not all the children treated have attained this degree of improvement, but Dr. Timme declared that "we have with these means accomplished more than by any previously known treatment, so far as I am aware."

### ITEMS

No diphtheria deaths in 1927 puts Cambridge, Mass., at the head of the list in diphtheria prevention, of all the cities with populations over 100,000 in the United States. Only once in the last five years, according to the American Medical Association, has any city gone a year without a single death from diphtheria. The previous diphtheria record breaker was Duluth, Minn., in 1925. Seven cities with more than 100,000 inhabitants had no typhoid deaths last year, the medical association's statistics show. New Haven, Conn., Springfield, Mass., Yonkers, N. Y., Paterson, N. J., Richmond, Va., Canton, Ohio, Kansas City, Kan., make up the typhoid honor roll, which is the largest known since studies of typhoid death rates were started in 1913.

THE pronghorn antelope of Nevada and Oregon have been given a new lease on life with the recent acquisition made by the National Association of Audubon Societies of a 380-acre ranch in northern Nevada. These beautiful and hard-pressed animals of the semidesert regions of the West were gradually being killed off, due mainly to lax game law enforcement. At a recent national conference, the association was appointed to take the lead in securing congressional action, but political interference at the behest of nomadic sheep-herding interests caused this project to fail.

A SURVEY of two centuries of rain in England shows that the rainfall of 1927 was 124 per cent. of the normal and was exceeded by only eight other years. The records, dating back to 1727, show that the three years 1768, 1852 and 1872 were markedly wetter than 1927, with 136, 137 and 144 per cent., respectively. There was no year so dry as 1921 with only 69 per cent. of the normal since 1788. The reports show that there were nine consecutive wet years from 1875 to 1883, while the longest run of dry years was only six, from 1800 to 1805. A remarkable feature of the rainfall of recent years is that in all but two of the last fourteen years the fall has been below average.